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Contents

Book Reviews

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Book Reviews

In This Issue

Trade. Few economic issues are currently of greater concern to policymakers in and out of agriculture. Recent articles in *Agricultural Economics Research* have made substantial contributions to trade-related problems, and the continuing interest is reflected in three of the four articles in this issue. Two of the three articles model relationships of key trade variables, and one argues the appropriate data set to represent exports. Research on trade and trade-related problems is given strong support in a special message to the journal from Clayton Yeutter, U.S. Trade Representative.

In the first article, Kitchen and Denbaly compare the mythic world of finance to the real world of commodity storage and exchange. To what extent can commodities be treated as portfolio assets as against real factors and products? The authors find that interest rates do influence commodity markets but that agricultural commodities, perhaps because of the conditions of production and storage, do not behave exactly like financial assets or durable commodities such as precious metals.

In the second article, Haley and Krissoff employ a three-country trade model on wheat and feed grains to isolate the effect of changes in exchange rates on trade, specifically exports. They show, with some reservations, that exchange rates make a difference. They cast doubt, then, on J.S. Mill's statement that ". . . all trade is in reality barter, money being a mere instrument for exchanging things against one another. . . ."

According to Ruppel, trade modelling must take proper account of the data used. In the third article, he uses three commodities to demonstrate that sales and shipments are not equivalent and, furthermore, that the lag/lead relationships differ widely among quarters. He argues that sales is the preferred economic variable.

The fourth article addresses not international trade but trade in the Adam Smith sense of town versus country. If you believe that hard tomatoes are good for you, you will also believe Kim and his associates that mechanical harvesters are good not only for producers (country) but consumers (town). However, the benefits to consumers are reduced by about 25 percent when the specification of a competitive model is replaced by a more realistic oligopsonistic model.

The topic of trade continues into our book reviews. Ballenger recommends the report of the Task Force for the Trilateral Commission called *Agricultural Policy and Trade: Adjusting Domestic Programs in an International Framework* by Johnson, Hemmi, and Lardinois as a concise, simple report on liberal trade policy.

Henneberry reviews Timmer's *Getting Prices Right*, an introductory-level book on agricultural price policy. He concludes that the book would nicely support a 2-week short course by nonspecialists but says little to the seasoned researcher.

Pavelis reviews the book by Easter, Dixon, and Hufschmidt, *Watershed Resource Management: An Integrated Framework with Studies from Asia and the Pacific,* which deals extensively with upstream-downstream externalities. He recommends it to both physical and social scientists.

Latham has the last word on books in this issue. Contributors to this journal should read both McCloskey's *The Writing of Economics* and Latham's review. She has been wanting to tell us something about our writing, and McCloskey gave her the excuse she needed. Have a look at her review; then beg, borrow, or buy the book.

With this issue Gerald Schluter joins editors-emeriti of our journal. He returns to the editorial board of *The Journal of Agricultural Economics Research* from which he came to serve us for 3 years as editor. From all of us in ERS, Gerry, thank you for your outstanding contribution to the journal's quality reporting of research in our Agency.

Gene Wunderlich

A Special Message on Trade and Agricultural Research to *The Journal of Agricultural Economics Research*

The Honorable Clayton Yeutter, U.S. Trade Representative

Today, more than ever, American farmers find themselves facing stiff competition from abroad. Nations that once seemed incapable of feeding themselves are now agricultural exporters. Other nations subsidize production and build up unnecessary surpluses. This situation has brought about a severe challenge to the competitiveness of U.S. agriculture.

The Government can—and should—level the international playing field by challenging unfair trading practices, by negotiating better trade agreements, and by improving the economic fundamentals that influence world trading patterns. But once that playing field is leveled, it is up to the agricultural community itself to produce the highest quality product at the most competitive price. That is why agricultural research is so essential to the future of American agriculture.

If the U.S. agricultural community is going to remain competitive in the world marketplace, it will have to rely increasingly on economic analysis in making decisions. We must continue reaching for new heights of intellectual innovation. Major commitments of time, resources, and energy will be needed to ensure that our economic research is the best in the world.

From my own perspective, the availability of sound research has been absolutely essential in the development and implementation of U.S. trade policy. Negotiators cannot afford to fumble around in the dark without necessary supportive data, particularly in the area of agricultural trade.

Agriculture is one of our priority areas for negotiation in the Uruguay Round. A major U.S. objective in this area is to draw up rules that will regulate and reduce the role of Government in agricultural trade. But before these negotiations proceed very far, we will need to determine how various Government policies such as subsidies, import barriers, and quota programs distort trade in agriculture. Agricultural economic analysis will be critical, then, to a successful outcome to the Uruguay Round of discussions on agriculture.

The role of economic research and analysis is just one example of why America needs to retain its competitiveness in the coming decades. "Competitiveness" also means that our children obtain the best possible educations, that the Government provides a stable and efficient economic environment in which our workers and businesses can produce, and that our trade policy remains geared toward opening markets throughout the world.

For American agriculture to remain competitive, American agricultural analysis and research must also remain competitive. I see no reason why that should not happen. We already have many of the best and most capable analysts in the world. In the past, we have set the standards of excellence in the international community.

American agriculture should not shrink from the challenges that lie ahead because out of these challenges will come new opportunities. We can take advantage of these opportunities if we maintain our commitment to agricultural research and analysis.

Arbitrage Conditions, Interest Rates, and Commodity Prices

John Kitchen and Mark Denbaly

Abstract. *This research examines the arbitrage condition between financial markets and commodity markets. According to the standard arbitrage condition, for risk-neutral investors to be indifferent between holding securities or commodities, the expected commodity price appreciation, adjusted for physical storage costs, must equal the rate of return on financial assets. For agricultural commodities, however, the convenience yield drives a wedge between the interest return and the commodity price spread. Empirical results support this position, but also provide evidence that the commodity price spread properly incorporates interest costs.*

Keywords. *Commodity prices, interest rates, arbitrage*

Over the past decade there has been increased interest in examining the response of flexible prices to macroeconomic shocks. International economists have theoretically and empirically analyzed the dynamics of flexible exchange rates and have extended the celebrated overshooting model of Dornbusch (*3*) to examine numerous factors affecting temporal exchange rate behavior.[1] A crucial component of these models is the interest parity condition (IPC), which specifies a relationship between interest rates and the implied dynamics of exchange rates.

A rapidly growing literature has extended the IPC and the overshooting-type analysis to primary commodity markets, particularly agricultural commodity markets. Frankel (*4*) has argued for using these models in agricultural research (*5, 6, 7*). Stamoulis, Chalfant, and Rausser (*18*) and Huffman and Langley (*10*) empirically tested the overshooting of agricultural prices, and Rausser (*17*) emphasized the importance of applying the overshooting response to agricultural models to explain the pricing behavior.[2]

The IPC is important in both exchange rate overshooting models and commodity price overshooting models. Given (1) the interest in the commodity price overshooting models, (2) their importance for policy decisions, and (3) the fundamental importance of the IPC in these models, we examined the IPC for primary commodity markets in greater detail. Although the IPC has been extensively tested for foreign exchange markets,[3] its validity for primary commodity markets has not been explicitly investigated.

Our objective in this study is to answer the following questions: Does commodity price behavior conform to the interest parity condition? If not, to what can we attribute the failure? What are the implications of the observed results for studies and models, like the overshooting analyses, that use the interest parity condition?

Theory

Interest parity conditions (IPC) specify relationships between interest rates and implied asset price dynamics such that risk-neutral investors are indifferent between holding a financial instrument and an alternative asset. If the IPC is a correct characterization of market behavior, a systematic violation of the IPC would provide for riskless profits and the market would be inefficient. For example, in the foreign

The authors are economists with the Agriculture and Rural Economy Division, ERS. An earlier version of this article was presented at the 1986 meetings of the Eastern Economics Association. Margaret Andrews, Gerald Schluter, and two anonymous reviewers provided helpful comments.

[1]Italicized numbers in parentheses refer to items in the References at the end of this article.

[2]Overshooting analyses examine the dynamics of price reactions to money shocks. "Overshooting" is variously defined in the literature as a more-than-proportionate response of the spot price relative to: (1) the money shock, (2) the expected future spot price, or (3) the (unobservable) current period "equilibrium" spot price (*14*). Note that with the first two definitions, given specific conditions or policies, undershooting is a possibility. For a discussion, literature review, and empirical information on overshooting versus undershooting, see Kitchen and Denbaly (*12*).

[3]Studies by Frenkel and Levich (*9*) and by Mishkin (*13*) are among many that demonstrate that covered interest rate parity holds in a static sense for interest rates and exchange rates. Husted and Kitchen (*11*), in their money announcement study, provide information on the implied dynamic responses of interest rates and exchange rates. They show that responses to money shocks are consistent with the covered interest parity condition. See Bilson (*1*) for a discussion on the failure of uncovered arbitrage to hold in international financial markets.

exchange market, the IPC specifies a relationship between interest rates and exchange rates such that investors are indifferent between holding domestic- and foreign-currency-denominated assets. Similarly, in commodity markets, the IPC specifies a relationship between interest rates and commodity prices such that investors are indifferent between holding commodities and financial instruments.

Interest parity conditions have been extensively examined and tested in the exchange rate literature. The uncovered (or open) IPC for exchange rates is:

$$\ln(E_t S_{t+j}) - \ln S_t = \ln(1 + i_{t,j}) - \ln(1 + i^*_{t,j}) \quad (1)$$

where $i_{t,j}$ and $i^*_{t,j}$ are the domestic and foreign j-period nominal interest rates, respectively; S_t is the spot exchange rate; $E_t S_{t+j}$ represents the rational expectation of the spot price in period t+j formed in period t; and ln is the natural logarithm. The exchange rates are specified as the domestic currency price of the foreign currency. The covered (or closed) IPC for exchange rates is:

$$\ln X_{t,t+j} - \ln S_t = \ln(1 + i_{t,j}) - \ln(1 + i^*_{t,j}) \quad (2)$$

where $X_{t,t+j}$ is the forward exchange rate for contracts to be delivered in period t+j. If the equality in equation 2 did not hold and there were no transactions costs, riskless profits could be made. For example, suppose that the left-hand-side (LHS) is greater than the right-hand-side (RHS)—that is, that the contracted rate of appreciation of the domestic currency is less than the difference in the rates of return on domestic and foreign bonds. In terms of a specific currency, the rate of return on foreign bonds would exceed that on domestic bonds. Domestic bonds could be sold at rate $i_{t,j}$ and one could use the domestic funds received from that sale to purchase the foreign currency at the spot rate S_t and the foreign funds could then be invested at rate $i^*_{t,j}$. Simultaneously, a forward contract to sell the foreign currency at rate $X_{t,t+j}$ would be made. In period t+j the funds from the foreign investment would be converted into the domestic currency at rate $X_{t,t+j}$. The resulting domestic funds would exceed the amount required to pay off the original loan, the difference representing the riskless profit.

As noted earlier, the direct application of the IPC to agricultural commodities for studying macroeconomic impacts is a fairly new procedure for agricultural economists. However, the concept was not unknown; it was discussed in a similar context in the "theory of the price of storage" of the agricultural marketing literature.[4] The theory of the price of storage indicates that, so long as supplies of a storable commodity are relatively large, the difference between the simultaneously quoted far- and near-term futures prices of the commodity will equal the full storage cost. In the literature, the full cost of storage is defined as the cost of warehousing and insurance plus the financial costs associated with implicit interest (opportunity) costs.

Assuming risk neutrality, the uncovered (or open) IPC for a storable commodity can be written as:

$$\ln(E_t P_{t+j}) - \ln(P_t + C_{t,j}) = \ln(1 + i_{t,j}) \quad (3)$$

where:

- $E_t P_{t+j}$ = the rational expectation formed in period t for the spot price in period t+j,
- P_t = the spot price in period t,
- $C_{t,j}$ = the j-period physical storage cost in period t, and
- $i_{t,j}$ = the j-period rate of interest observed in period t.

The covered (or closed) IPC requires that a future delivery price be specified in the current period, thus eliminating the risk associated with uncertainty about changes in the spot price over the holding period. This condition is represented as:

$$\ln F_{t,t+j} - \ln(P_t + C_{t,j}) = \ln(1 + i_{t,j}) \quad (4)$$

where $F_{t,t+j}$ is the price for a futures contract to be delivered in period t+j as set in period t. The covered arbitrage condition specified here differs from the uncovered case because there is a *contracted* rate of commodity price appreciation rather than just an *expected* rate. The covered IPC indicates that, if the LHS in equation 4 were greater than the RHS, funds could be borrowed at rate $i_{t,j}$ and that, simultaneously, the commodity would be purchased at the spot price P_t and a futures contract would be sold at the futures price $F_{t,t+j}$. The commodity would be stored at cost $C_{t,j}$ over the j-period horizon to delivery. In period t+j the commodity would be delivered, and price $F_{t,t+j}$ would be received. The funds received would exceed the cost of the original loan, and riskless profits would be made. This scenario is extreme in the sense that only a small percentage of futures contracts are ever delivered. However, the relationship is the exact

[4]See Peck (*16*) for a concise summary.

linkage that constrains futures markets to be closely tied to spot markets.[5]

A potential problem arises in applying the IPC to commodity markets. If the RHS were greater than the LHS in equation 4, the opportunity for riskless profits would not exist. For international financial markets, either currency could be borrowed for immediate use and the debt could be repaid later. However, a commodity to be produced in the future cannot be "borrowed" from the future to be sold in the spot market for possession today. (If such an activity were possible, it would drive the spot price down relative to the future price, increasing the LHS spread until it equalled the RHS). In the absence of a riskless profit motive, another force might maintain the IPC. The requirement is that commodity holders treat the commodity as a portfolio asset. In this risk-neutral framework and if one abstracts from transactions costs, if the rate of return on financial assets exceeded the rate of return on commodities, portfolios would be realigned with commodities being sold and financial assets being purchased until the rates of return were equated. If commodities were held for purposes other than as portfolio assets (for example, as primary inputs into a production process), the IPC could be systematically violated. That is, the condition in equation 4 would then be:

$$\ln F_{t,t+j} - \ln(P_t + C_{t,j}) \leq \ln(1 + i_{t,j}) \qquad (4')$$

We would expect that the more a commodity deviated from being simply a portfolio asset, the greater would be the deviation from the IPC.

Precious metals are perfectly storable, are continuously produced, and are held primarily as portfolio assets. Under these conditions, arbitrage should ensure the equality of the price spread and the interest rate. Agricultural commodities, however, are produced seasonally, and supplies can be occasional and relatively small. Under relatively small supplies, the price difference can drop below the full cost of storage and may even be negative ("inverse carrying charges"). As scarcity increases and as the spot price is driven up relative to the future price, the resulting drop in the price difference creates a disincentive for storage, as the return on storage falls below that required to cover full storage costs. Under such conditions, for the IPC to be violated, stockowners must attach intrinsic value to their available stocks and possession of the commodity allows them to meet current use requirements. When supplies are relatively small, commodity ownership can provide what is typically called a "convenience yield" (the liquidity premium for the commodity is greater than zero). The convenience yield explains the inequality in equation 4′.

Empirical Evidence and Interpretation

The theoretical presentation produced specifications for testing the covered and uncovered versions of the IPC. By treating the interest rate as exogenous, we can estimate the following regressions:

$$\ln F_{t,t+j} - \ln(F_{t,t} + C_{t,j}) = a + b \ln(1 + i_{t,j}) + e_{t,j} \quad (5)$$

$$\ln F_{t+j,t+j} - \ln(F_{t,t} + C_{t,j}) = c + d \ln(1 + i_{t,j}) + w_{t+j,j} \quad (6)$$

where $F_{t,t+j}$ is the price in period t of a futures contract to be delivered in period t + j ($F_{t,t}$ and $F_{t+j,t+j}$ are analogously defined) and $i_{t,j}$ is the j-period nominal rate of interest observed in period t. In equations 5 and 6 the spot price is represented by the futures price for contracts with current period delivery.[6]

The LHS in equation 5 is the contracted rate of change in the commodity price; thus, equation 5 is the regression for testing the covered IPC. Using the assumption of rational expectations so that the actual

[5]Equations 3 and 4 are written differently from those generally used in the literature (*5*, p. 345, equation 1). First, the IPC equations often use the interest rate directly rather than ln (1+i). This procedure can be justified through an approximate equality in the IPC since ln (1+i) ≅ i when i is "close" to zero. Second, in the literature, the storage cost term is usually assumed to be "constant" and to enter additively in logarithms as in:

$$(\ln E_t P_{t+j} - \ln P_t) - sc \cong i_{t,j}$$

However, for this equation to be correct, storage costs must be a constant percentage of the spot price, a condition that is systematically violated for agricultural commodities. Note that:

$$-\ln(P_t + C_{t,j}) \cong -\ln P_t - sc \quad \text{iff} \quad C_{t,j} = sc\, P_t$$

To avoid these problems, we used the formulation of the text with the per-unit storage cost entering additively with the level of the spot price.

[6]The price on the current-delivery futures contract differs from the spot price by the basis. The basis accounts for quality, location, and other differences between the spot and futures markets. To assure homogeneity of the commodity for both the near- and far-term prices across time, we used the current-delivery futures price rather than the cash spot price.

We did not use storage cost data to adjust the price spread for precious metals. Unlike agricultural commodities, which are bulky and have significant storage costs that vary greatly as a percentage of price, precious metals can be stored at a cost that is typically a small and fairly constant percentage of the spot price. This storage cost percentage would then be captured in the intercept term in the precious metals regressions.

Other variables that explain the LHS price spreads in equations 5 and 6 that are omitted are assumed to be orthogonal to the interest rate.

price deviates from the prior expectation by a random error, that is,

$$\ln F_{t+j,t+j} = \ln E_t F_{t+j,t+j} + u_{t+j,j}$$

we can use equation 6 to test the uncovered IPC. If the IPC is a correct characterization of commodity price behavior, the testable joint hypothesis in each case is (a,b) = (0,1) and (c,d) = (0,1).

Note that the Frankel-type IPC relations do not explicitly account for transactions costs, particularly the margin deposit required for selling the far-term futures contracts for the covered IPC case. Incorporating the margin deposit yields:

$$\ln (F_{t,t+j}(1+m)) - \ln (F_{t,t} + C_{t,j} + mF_{t,t+j}) = \ln (1 + i_{t,j}) \quad (7)$$

where m is the margin percentage. The difference between equations 4 and 7 is the interest cost of the margin deposit. Under the IPC, equation 7 can be rewritten as:

$$\ln (F_{t,t+j}) - \ln (F_{t,t} + C_{t,j}) = \ln (1 + i_{t,j}) - \ln (1 - mi_{t,j}) \quad (7')$$

The RHS of equation 7′ is slightly *larger* than the RHS of equations 3 and 4, but more important, the omitted variable in regressions like equations 5 and 6 will be correlated with the regressor, leading to possible coefficient bias. For estimating regressions based on equation 7 we assumed that m was 10 percent. Note, however, that large traders can deposit Treasury bills as margin and the interest would accrue to the trader, so the role of margin interest in the price spread may not be very important.

We acquired data for futures prices and interest rates for 1971-86. Futures prices for two types of storable commodities, precious metals and agricultural grains, were taken from the Chicago Board of Trade *Statistical Annual.* The sample period for precious metals covers the shorter 1975-86 period.[7] To avoid estimation problems associated with overlapping data or the use of period averages, we drew the data for the futures prices from the first business days of March and September for the March and September contracts.[8] This procedure establishes the time horizon, j, to be 6 months; thus, there are two observations per year in a time series format. For example, for March observations, the futures price at closing on the first business day of March for a March delivery contract is used for the near-term price. The far-term, 6-month ahead, price is the futures price for September delivery contracts at closing on the first business day of March. September observations are analogous, with September delivery contract prices specifying the near-term price and March delivery contract prices specifying the far-term prices. The market yield for 6-month Treasury bills was used for the interest rate. We divided the annual yield by two to convert it to a 6-month rate of return. The near-term prices for agricultural commodities were adjusted to account the the 6-month physical (noninterest) storage cost. The physical storage cost data for the various grains came from the Agricultural Stabilization and Conservation Service (ASCS).[9] We divided the reported annual values by two to obtain a 6-month storage cost.

The use of Commodity Credit Corporation (CCC) storage cost data merits further discussion. Paul used an approach similar to ours to examine the pricing of binspace in the 1952-65 period (*15*). By (1) adjusting the far-near price spread (the carrying charge) for interest and commission costs, (2) dropping the May-July observations, (3) assuming that the convenience yield on at least one of the five commodities examined was zero in each remaining observation period, and (4) using the largest value of the interest/commission cost-adjusted carrying charge among the five commodites, Paul obtained an estimate of the competitive price of binspace. The estimated competitive price varied above and below the CCC storage rate, but on average the estimated price was below the CCC rate (11.6 cents vs. 13.8 cents per bushel). This final average result conformed with the conceptual view advanced by Paul that the CCC rate would tend to exceed the competitive price.

We cannot claim here, by using the CCC rates, that we have an exact proxy for the true competitive physical storage cost. We recognize the limitations of its use. The CCC rates can be written as the sum of the true competitive physical storage cost plus an error. In our estimated regressions the additional error would, as a percentage of the price, enter into the RHS of the relationship. Systematic components of the error would be captured in the estimated intercept, and random components would enter into the regression error. If the CCC rates were systematically

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[7]Data for the most recent futures observations were supplied by an anonymous reviewer.

[8]See Cumby and Mishkin (*2*, pp. 6-7) for a discussion of estimation problems associated with overlapping data. The sampling technique we used matches the forecasting interval with the sampling interval. If we had taken additional observations within the sample, the forecasting and sampling intervals would have "overlapped" and the regression errors would have followed an autoregressive process. Although there are estimation procedures that account for these problems, we chose to avoid the error structure problem and thereby preserve the desirable properties of ordinary-least-squares estimation.

[9]We thank Linwood Hoffman of ERS for providing us with the storage cost data. The data were Government storage costs from the ASCS Warehouse Division of Commodity Operations.

larger than the true competitive price, the intercept estimate would be biased downward. However, this information and the data suggest that the magnitude of the bias would be small, ranging from 0.33 for soybeans to 1.19 for oats with an average across the grains of 0.71.

Tables 1 and 2 show the results for the covered IPC of equation 5 and the margin-adjusted form based on equation 7. All the coefficient estimates for the interest rate term have correct signs, and t-tests reveal that these estimates do not differ significantly from 1.0, as hypothesized. The intercept estimates for precious metals are not significantly different from zero, as hypothesized. However, significant negative intercepts are observed for the agricultural grains regressions (the oats and corn intercepts are significant at approximately the 6-percent and 14-percent levels, respectively). The F-statistics for testing the hypothesis that (a,b) = (0,1) indicate that the joint relation for covered IPC cannot be rejected for metals, but the hypothesis is rejected in every case for grains at the 1-percent level. The results for the unadjusted and margin-adjusted forms are similar, and the bias does not appear to be that important.

Tables 3 and 4 show the results for the uncovered IPC of equation 6. None of the coefficient estimates is significantly different from zero. However, the slope coefficient is significantly different from 1.0 only for the stacked grains regression, whereas the joint (0,1) hypothesis is rejected only for corn and oats. Therefore, one must conclude the variance of the expectation error is quite large relative to the variance of the true regression error. That is, the proper regression would use the actual expectation so that the true version of equation 6 would be:

$$\ln E_tF_{t+j,t+j} - \ln(F_{t,t} + C_{t,j}) = c + d\ln(1 + i_{t,j}) + z_{t+j,j} \quad (6T)$$

The difference, as previously stated, is the expectation error $u_{t+j,j}$. By estimating equation 6 and using the proxy LHS, we find that the regression error in equation 6 includes both the true regression error and the expectation error:

$$w_{t+j,j} = z_{t+j,j} + u_{t+j,j} \quad (8)$$

Because of the additional component in the regression error, the standard errors in the estimated relationship increase, and hypothesis testing is compromised. These relationships help explain the absence of statistical significance in the uncovered IPC results of tables 3 and 4.

Note an important characteristic of financial and primary commodity markets: the role of "news." Much attention has recently been devoted to models that explicitly account for information and the ways in which new information (the "news") affects prices. Frenkel (*8*) and others developed the "news" concept, applying it to international financial markets to examine exchange rate adjustment. A whole literature uses "news" frameworks to examine the response of various prices and rates to the weekly money supply announcements. Articles by Frankel

Table 1—Covered IPC regressions for precious metals

Commodity	a	b	R^2	DW	F	n
Gold	0.880 (1.081)	0.866** (.241)	0.392	1.80	0.57	22
Silver	-1.339 (1.843)	1.293** (.411)	.310	1.89	.27	22
Margin adjusted:						
Gold	.804 (.978)	.784** (.218)	.392	1.80	.56	22
Silver	-1.209 (1.673)	1.170** (.373)	.309	1.89	.53	22

Ordinary-least-squares estimation.
Standard errors appear in parentheses.
** = significantly different from zero at the 0.01 level.
* = significantly different from zero at the 0.05 level.
DW = Durbin-Watson statistic.
F = the calculated value of the test statistic used for testing the null hypothesis: H_O: (a, b) = (0, 1). The critical value is $F_{.05, 2, 20} = 3.44$
n = number of observations.

Table 2—Covered IPC regressions for grain commodities

Commodity	a	b	R^2	DW	F	n
Wheat	−8.809* (4.236)	1.704 (.991)	0.090	1.85	8.65**	32
Soybeans	−8.573** (3.295)	1.915** (.711)	.171	2.04	10.01**	32
Corn	−4.035 (2.601)	.583 (.609)	.030	1.68	20.48**	32
Oats	−9.077 (4.677)	1.003 (1.095)	.027	1.57	15.80**	32
Stacked grains	−7.623** (1.905)	1.301** (.446)	.063	1.69	11.41**	128
Margin adjusted:						
Wheat	−8.051* (3.879)	1.552 (.908)	.089	1.85	9.70**	32
Soybeans	−7.829** (3.030)	1.746** (.709)	.168	2.04	11.27**	32
Corn	−3.673 (2.374)	.528 (.556)	.029	1.68	23.45**	32
Oats	−8.302 (4.275)	.914 (1.000)	.027	1.57	17.21**	32
Stacked grains	−6.964** (1.744)	1.185** (.408)	.063	1.70	12.77**	128

Ordinary-least-squares estimation.
Standard errors appear in parentheses.
** = significantly different from zero at the 0.01 level.
* = significantly different from zero at the 0.05 level.
DW = Durbin-Watson statistic.
F = the calculated value of the test statistic used for testing the null hypothesis: H_O: (a, b) = (0, 1). The critical value is $F_{.01, 2, 20} = 5.39$ and $F_{.01, 2, 126} = 4.77$.
n = number of observations.

Table 3—Uncovered IPC regressions for precious metals

Commodity	a	b	R^2	DW	F	n
Gold	9.16 (19.95)	−1.87 (4.34)	0.010	1.82	0.39	21
Silver	25.92 (27.75)	−5.57 (5.94)	.040	2.26	0.74	21

Ordinary-least-squares estimation.
Standard errors appear in parentheses.
** = significantly different from zero at the 0.01 level.
* = significantly different from zero at the 0.05 level.
DW = Durbin-Watson statistic.
F = the calculated value of the test statistic used for testing the null hypothesis: H_O: (a, b) = (0, 1). The critical value is $F_{.05, 2, 19} = 3.52$
n = number of observations.

Table 4—Uncovered IPC regressions for grain commodities

Commodity	a	b	R^2	DW	F	n
Wheat	7.03 (10.86)	−2.36 (2.52)	0.029	1.50	2.46	31
Soybeans	15.13 (10.85)	−3.92 (2.51)	.077	2.46	2.76	31
Corn	−2.06 (10.26)	−.72 (2.38)	.003	1.43	3.57*	31
Oats	−8.00 (9.59)	.27 (2.22)	.001	1.87	5.62**	31
Stacked grains	3.02 (5.15)	−1.68 (1.19)	.016	1.82	2.96	124

Ordinary-least-squares estimation.
Standard errors appear in parentheses.
** = significantly different from zero at the 0.01 level.
* = significantly different from zero at the 0.05 level.
DW = Durbin-Watson statistic.
F = the calculated value of the test statistic used for testing the null hypothesis: H_O: (c, d) = (0, 1). The critical value is $F_{.05, 2, 29} = 3.33$ and $F_{.01, 2, 29} = 5.42$, $F_{.05, 2, 122} = 3.07$.
n = number of observations.

and Hardouvelis (*6, 7,*) and by Kitchen and Denbaly (*12*) are relevant examples. Frankel and Hardouvelis show that commodity prices and interest rates react quickly to the news in the money announcement. Kitchen and Denbaly present results that indicate that far-term and near-term commodity prices and interest rates react in a fashion consistent with the covered IPC. Given the sensitivity of these prices to new information, it is not surprising that the expectation errors could have relatively large variances (as we suggested above).

How should we interpret the results presented here in conjunction with existing evidence? First, the importance of the IPC for commodity price behavior varies greatly across commodities, depending on the extent to which the commodity can be treated as a portfolio asset. The covered IPC appears to be an accurate description for gold and silver, but not for grains. Second (and related to the first point), the commodity IPC should generally be stated as an inequality as in equation 4′ rather than as a strict equality as in equation 4. The theoretical and empirical evidence supports such an interpretation. In fact, Frankel (*5*) and Frankel and Hardouvelis (*6*) acknowledge the potential problems with using the arbitrage condition since in their model the inflation term for primary commodity prices exceeds that for the manufactures prices by an amount equal to the equilibrium real interest rate plus the (invariant percentage) storage cost:

> This is a general problem with the commodity arbitrage condition. There are two possibilities. First, for an agricultural commodity, [the equilibrium commodity price] may gradually increase relative to [the equilibrium manufactures price] (monetary considerations aside) during most of the year, as long as some of the previous harvest peak is being stored, and fall discontinuously when the new harvest comes in. Thus, there is no longrun trend in [the difference between the normalized commodity and manufactures equilbrium prices]. Alternatively, for a nonperishable, nonrenewable commodity such as gold or oil, there may indeed be a longrun trend in [the difference in equilibrium prices], a la Hotelling (*5*, p. 146).

If the IPC for commodities were stated as an inequality, problems with the interpretations in these models would be reduced.

Finally, a key point about the overshooting models and analyses and the use of the IPC is that their value lies in their ability to examine the responses of flexible prices to macroeconomic shocks. If, in response to macroeconomic shocks, commodity prices react "as if" the IPC were correct—that is, a conditional IPC—one should not discount the value of the IPC. It would then be correct to use the IPC in such a context, even if the IPC does not hold exactly for commodity-specific (not macroeconomic) reasons. For

example, we were unable to reject the hypothesis that the interest rate term had a coefficient of 1.0 so that, *ceteris paribus* (abstracting particularly from systematic convenience yield relationships), changes in the interest rate would be reflected in changes in implied commodity price dynamics. The IPC inequality arises from factors other than the interest rate, so the far-near price spread incorporates the interest rate in addition to other nonmonetary components.

Conclusions

We have examined and tested the arbitrage condition between financial markets and commodity markets. The empirical results confirm the importance of interest costs in the determination of commodity prices. Although statistical tests based on regression analysis were unable to reject the covered interest parity condition for precious metals, such tests provided strong evidence for rejecting the covered interest parity condition for agricultural grains. For grains, the failure of the condition was interpreted as resulting from a convenience yield (rather than, for example, from market inefficiency). The linkage from interest rates to commodity futures contract prices is consistent with assumptions typically used in examining futures prices—that is, the direct incorporation of interest costs. However, the interest rate linkage to price dynamics implied *ex ante* by covered arbitrage does not carry through to actual price dynamics observed *ex post facto*. As with exchange rates, uncovered interest parity conditions do not generally hold for commodity prices, so the value of such conditions for purposes of prediction is unclear.

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In Earlier Issues

From the algebraic analysis of the free trade model, we can conclude that:

- The percentage change in equilibrium price and quantity depend on the elasticities of the excess supply and demand relationships. The percentage change in equilibrium price will not exceed the percentage change in the exchange rate; the percentage change in equilibrium quantity traded may or may not exceed the percentage change in the exchange rate.
- The percentage change in quantity traded will exceed that of the price change if the elasticity of the excess supply function exceeds one.
- The elasticities of excess supply and demand relationships may be elastic even if the underlying domestic supply and demand relationships are inelastic.
- Given elastic import demand and export supply relationships, the percentage change in quantity traded due to an exchange rate change may be quite large.

Maury E. Bredahl and Paul Gallagher
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U.S. Grain Exports and the Value of the Dollar

Stephen L. Haley and Barry Krissoff

Abstract. *This article examines the changes in grain exports from 1973 to 1985. A simplified three-country trade model is introduced as a framework for analyzing U.S. grain trade, world grain trade, and market price when changes in two real effective exchange rates occur: an exchange rate based on U.S. trade with grain importers and an exchange rate based on global trade of grain competitors. Although collinearity in the data series makes implementation of the theoretical model difficult, evidence suggests that the cumulative effect of a 1-percent depreciation (appreciation) in the value of the dollar was to expand (contract) U.S. wheat exports in the range of 2.3 percent and to expand feed grain exports in the range of 1.4 percent. Wheat exports have adjusted to real exchange rate changes only over a long period of 10 - 12 quarters. Feed grain exports have been quicker to adjust to real exchange rate changes, but there are significant lagged effects.*

Keywords. *Grain, international trade, exchange rates*

U.S. grain exports have dropped dramatically in the eighties. The value of U.S. exports of wheat and wheat products dropped from a historical peak of $8.1 billion in 1981 to $4.5 billion in 1985, a 44-percent decrease. The decline for feed grains has been of a similar magnitude, from $10.4 billion to $6.8 billion. Moreover, the U.S. share of the world market for grains fell from 54 to 39 percent over the period.

One possible explanation for deteriorating exports has been the sustained appreciation of the U.S. dollar in the early eighties. Measured in trade-weighted terms against the currencies of other wheat and feed grain exporters, inflation-adjusted effective exchange rates increased 43 and 58 percent, respectively, from 1979 to 1985. The dollar similarly appreciated 46 and 64 percent against the weighted average of currencies of countries that import U.S. wheat and feed grains.

A testable hypothesis is that changes in the value of the dollar inversely affect grain exports. An increase (decrease) in the value of the dollar, all else constant, decreases (increases) grain exports. Because the United States supplies much of the world grain market, changes in the real exchange rate affect the world price of grain. When the dollar appreciates, the own-currency price of grain increases for export competitors and grain importers. Export competitors are encouraged to export, and importers are less eager to import at higher prices. Unless export supplies of competitors are highly responsive to the price change, total world grain exports decrease. The United States loses both in grain exports and market share.

Our purpose is to investigate the effect of changes in the value of the dollar on U.S. grain exports. We focus on the direct effect of a change in the dollar's value on the international price of grain. The analysis is, therefore, based on a partial equilibrium model of the world grain market. It abstracts from indirect effects of exchange rate changes on grain trade.

We address the following questions:

1. What are the relevant parameters for analyzing the effect of changes in the value of the dollar on U.S. grain exports? This question requires us to consider the value of the dollar as weighted against both export competitors and grain importers.

2. How long does it take for changes in the value of the dollar to affect grain export levels? Exchange rate changes influence both excess supply of exporters and excess demand of importers. Given the seasonality of grain production, sunk investments in specific capital stocks, and agricultural policies of the U.S. and foreign governments that produce market distortions, exchange rate changes are likely to influence export levels only over a long period.

3. Given the experience of the floating exchange rate period, what is the quantitative effect of a specified exchange rate on grain exports? How much confidence can be attributed to this number?

Haley is an agricultural economist and Krissoff is an economist with the Agricultural Trade Analysis Division, ERS. The authors thank Dave Stallings and Steve Magiera for their reviews. They also benefited from comments by participants in the ERS seminar on "Macroeconomic Linkages to U.S. Agriculture" and the "Wheat Prototype Study" as well as from anonymous reviewers.

To answer question 1, we present a trade model that theoretically evaluates the effect of changes in the value of the dollar on grain exports. The model includes three countries: the U.S. grain exporter, the rest-of-world (ROW) exporter, and the ROW importer. Changes in the value of the dollar are measured against both the ROW exporter and the ROW importer. The exchange rates are used in the reduced-form version of the model to answer questions 2 and 3.

Model Structure

We use a partial-equilibrium trade model to simplify tracing the effects of changes in macroeconomic variables and U.S. agricultural policy on grain exports. We assume competitive markets and no backward linkages from agricultural exports to exchange rates. Domestic demand in exporting countries and domestic supply in the importing country are assumed to be perfectly inelastic so that concentration is focused on trade flows.[1] All variables in the model are in real terms; the volume of trade is affected by real importer income and real prices. Furthermore, the United States is one of the grain exporters, and the world price of grain is quoted in dollars.

Supply of U.S. grain exports (Q^A_s) is based on the real price of grain (wp) and U.S. agricultural policy, that is, the real target price (tp) and the real support price (sp):

$$Q^A_s = S^A(wp,tp) - L^A(sp/wp) \qquad (1)$$

where $S^A(wp,tp)$ and $L^A(sp/wp)$ represent excess supply from current production and the flow of grain into public stocks, respectively. If the real price of grain (wp) increases, farmers are encouraged to allocate more resources to this commodity, and grain production will rise. (Conversely, if the price of other goods and services increases more than grain prices, farmers will turn to these higher priced commodities, and grain supply will diminish.) Higher target prices (tp) increase deficiency payments that in turn augment exports. The ratio of support to actual grain price, sp/wp, determines the flow into public stocks. If the support price rises relative to the grain price, farmers will place more of their product in public stocks rather than in exports; hence, the negative sign before L^A.

The ROW export supplier bases its supply decision to the world market on the local price of grain:

$$Q^F_s = S^F(ef \cdot wp) \qquad (2)$$

where the supplier's price is converted to local currency by ef, defined as the real foreign currency price of the dollar. Use of the real exchange rate automatically translates the world price of grain into the real price for the ROW exporter.[2] When the dollar depreciates (appreciates), the foreign supplier's domestic price of grain falls (rises), and the quantity supplied will decline (increase).

Excess demand for grain exports (Q_d) depends on the importer's real income (y) and the importer's grain price in local currency:

$$Q_d = D(y,em \cdot wp) \qquad (3)$$

where em represents the importer's price of the dollar.[3] If grain is a normal good for world importers, an income increase would augment foreign demand. Similarly, if the local currency price of grain declines, perhaps because of a dollar depreciation, the quantity demanded will increase.

By definition, total world exports equal the sum of U.S. and other countries' exports:

$$Q_s = Q^A_s + Q^F_s \qquad (4)$$

Finally, the market clearing condition is:

$$Q = Q_s = Q_d \qquad (5)$$

or world excess supply equals excess demand.

Comparative Statics

Equations 1-3 are assumed to be continuous functions. To determine the effect of small changes in the system, we have logarithmically differentiated the five equations:

$$Q^A_s{}^* = (\alpha_1\sigma^A + \alpha_2\pi)wp^* + \alpha_1\Phi(tp)^* - \alpha_2\pi(sp)^* \qquad (6)$$

[1]Real income changes in the exporting countries are also assumed not to affect domestic demand. Most major grain-exporting nations are developed countries for which the income elasticity for grain would be expected to be lower than that for most grain importers. To simplify the algebra, we implicitly assume that the income elasticity in the exporting countries is zero.

[2]In this model, the real price of U.S. grain (wp) is the nominal price (wpn_{us}) divided by the wholesale price index (wpi_{us}). The real exchange rate is the nominal exchange rate ejn (measured as currency units of country j per dollar) adjusted for the ratio of the U.S. wpi to the foreign wpi; that is, $ej = (ejn)\bullet(wpi_{us}/wpi_j)$. The law of one price translates the nominal U.S. price into the nominal foreign price $(ejn)\bullet(wpn_{us}) = wpn_j$. Multiplication of the real U.S. grain price by the real exchange rate yields the real price of grain denominated in foreign currency units as follows:

$$(ej)\bullet(wp) = (ejn)\bullet(wpi_{us}/wpi_j)\bullet(wpn_{us}/wpi_{us}) = wpn_j/wpi_j$$

[3]Note that ef and em are two distinct exchange rates. Although both measure the value of the U.S. dollar, ef does so in terms of the ROW *competitor's* currency, and em, in terms of the ROW *importer's* currency.

where a superscript * on a variable indicates the percentage change in that variable, and where:

σ^A = export supply elasticity with respect to price for country A,
π = stock supply elasticity with respect to the ratio of support to actual price,
Φ = export supply elasticity with respect to the target price, and
$\alpha_1 = S^A/Q^A_s$, $\alpha_2 = L^A/Q^A_s$.

$$Q^F_s{}^* = \sigma^F(wp^* + ef^*) \tag{7}$$

where σ^F = foreign supply elasticity with respect to the local price;

$$Q_d{}^* = -\cap(em^* + wp^*) + \delta y^* \tag{8}$$

where:
$\cap$ = import demand elasticity with respect to local price, and
δ = import demand elasticity with respect to income;

$$Q^* = Q_s{}^* = Q_d{}^* \tag{9}$$

$$Q_s{}^* = \Theta^A Q^A_s{}^* + \Theta^F Q^F_s{}^* \tag{10}$$

where $\Theta^i = Q^i_s/Q_s$, or market share.

Reduced-form equations for price, export volume, and market share can be derived from equations 6-10. A change in the exogenous variables affects the endogenous variables in several ways. First, the world price equals:

$$wp^* = -\frac{\Theta^A \alpha_1 \Phi}{\Omega} tp^* + \frac{\Theta^A \alpha_2 \pi}{\Omega} sp^* - \frac{\Theta^F \sigma^F}{\Omega} ef^* - \frac{\cap}{\Omega} em^* + \frac{\delta}{\Omega} y^* \tag{11}$$

where $\Omega = \Theta^A\alpha_1\sigma^A + \Theta^A\alpha_s\pi + \Theta^F\sigma^F + \cap$. A depreciation in the real value of the dollar, ef* or em*, increases the real dollar grain price because the importer demands more U.S. commodities and the ROW exporter supplies less grain to the world market. However, the real grain price to the importer and to the ROW exporter in terms of their own currencies is lower. Hence, the quantity demanded is more for the importer, and the quantity supplied is less for the exporter.

The export volume (12) and market share (13) equations for the United States are:

$$Q^{A*} = \frac{\alpha_1 \Phi(\Theta^F \sigma^F + \cap)}{\Omega} tp^* - \frac{\alpha_2 \pi(\Theta^F \sigma^F + \cap)}{\Omega} sp^* - \frac{\Theta^F \sigma^F(\alpha_1 \sigma^A + \alpha_2 \pi)}{\Omega} ef^* - \frac{\cap(\alpha_1 \sigma^A + \alpha_2 \pi)}{\Omega} em^* + \frac{\delta(\alpha_1 \sigma^A + \alpha_2 \pi)}{\Omega} y^* \tag{12}$$

$$\Theta^{A*} = \frac{\Theta^F \alpha_1 \Phi(\sigma^F + \cap)}{\Omega} tp^* - \frac{\Theta^F \alpha_2 \pi(\sigma^F + \cap)}{\Omega} sp^* - \frac{\Theta^F \sigma^F(\alpha_1 \sigma^A + \alpha_2 \pi + \cap)}{\Omega} ef^* - \frac{\Theta^F \cap(\alpha_1 \sigma^A + \alpha_2 \pi - \sigma^F)}{\Omega} em^* + \frac{\Theta^F \delta(\alpha_1 \sigma^A + \alpha_2 \pi - \sigma^F)}{\Omega} y^* \tag{13}$$

A real decrease in the value of the dollar for importers and/or exporters unambiguously increases trade volume share for the U.S. exporter, all else constant. (Note the negative signs on the exchange rate terms in equation 12.) World importers purchase more grain as they believe that the real (local) price has declined because of the dollar depreciation. The import demand ($\cap$), the export supply (for both exporters, σ^A and σ^F), the stock supply (π) elasticities, and the initial market share (Θ^F) determine the magnitude of the effect.

U.S. agricultural policy alters export price and quantity responsiveness, depending on the closeness of the loan rate to the world market price and participation rate in the programs. Increases in the support price directly influence world grain prices, but inversely affect U.S. exports. Rather than exporting more grain, U.S. producers increase the flow of grain into public stocks. Conversely, the target price acts as an export subsidy. Increases in the target price reduce the dollar grain price but augment U.S. exports.[4] The

[4]The effect of the target price on exports could be moderated by the effect of land diversion requirements for deficiency payment eligibility. However, this issue is not straightforward. As Love and others (*5*) have noted, if farmers are indifferent to program participation, an increase in the diversion requirement will cause them to leave the program, in which case they increase the acreage they plant. On the other hand, if farmers are inclined to participate, then an increase in the diversion requirement will lead them to divert more acreage to stay in the program. Although this issue has relevance to this study, it is not incorporated into the model. Italicized numbers in parentheses refer to items in the References at the end of this article.

effect of the policy instruments taken together is an empirical question. The target price could partially, fully, or more than offset the support price.

Estimation Procedure

We use equation 12 to investigate how changes in the value of the dollar affect U.S. grain exports and to empirically analyze these relationships. Equation 12 is integrated to yield:

$$\ln Q^A = a_0 + a_1 \bullet \ln(em) + a_2 \bullet \ln(ef) + a_3 \bullet \ln(y) + a_4 \bullet \ln(tp) + u \quad (14)$$

where u is the error term, which is assumed to be normally distributed with an expected value of zero; a_0 is the constant of integration; and the other variables are defined as before.[5] The model maintains that changes in U.S. grain exports vary directly with changes in the real target price and importer income and vary inversely with changes in the real loan rate and in both real exchange rates. The structural parameters shown in equation 12 are implicit in the regression coefficients.

Two issues complicate the estimation of equation 14: the dynamics and the collinearity of the variables. Large price fluctuations may change quantity supplied only slightly in the short term. First, fixed costs in agriculture tend to be high because agricultural capital has no readily available alternate uses outside agriculture. Second, movements in exchange rates, as well as in support and target prices, may not be transmitted quickly to ROW exporters or importers. Third, the agricultural sector is subject to government-imposed policy distortions. Changes in exchange rates or U.S. policy instruments may not affect foreign internal agricultural prices in any set, predictable manner. Nonetheless these changes will affect the opportunity cost of insulating a nation's agricultural sector. These issues strongly argue for the specification of lagged effects of exchange rates and policy variables on trade. Therefore, it is important to determine how long exchange rate and policy changes will affect export levels.

Collinearity among some of the explanatory variables makes the estimation of equation 14 difficult. The two exchange rate variables tend to move in the same direction over the flexible rate period. For wheat, the correlation of the logarithms of the competitor and importer exchange rates is 0.86. For feed grains, the correlation is 0.77. The domestic policy instruments (target and support prices) have been typically adjusted at the same time and in the same direction. For wheat, the correlation of the target and support prices is 0.96. For feed grains, it is 0.97. The correlation between these variables obscures the contribution of each variable to changes in grain export levels.

The approach we employ is to drop from equation 14 one of the variables from each set of correlated variables. The interpretation of the corresponding regression coefficients will then change. For the exchange rate variable, the regression coefficient would now account for the sum of the import price elasticity and the competitor supply elasticity weighted by its share of the market. For the domestic policy variable, the regression coefficient is a weighted average of the difference between the domestic supply elasticity with respect to the target price and the stock elasticity with respect to the support price. The sign on the latter coefficient cannot be determined a priori because it involves the difference of two nonnegative elasticities. The sign depends on whichever effect is stronger during the estimation period.

The error term of a revised version of equation 14 becomes correlated with each of the respective coefficients on the exchange rate and domestic policy variables. Consider equations 15 and 16, which reflect the proposed relationship between the exchange rates and between the domestic policy instruments:

$$\ln(ef) = b_{10} + b_{11} \bullet \ln(em) + e_1 \quad (15)$$

$$\ln(sp) = b_{20} + b_{21} \bullet \ln(tp) + e_2 \quad (16)$$

If one were to assume that $b_{10} = b_{20} = o$ and $b_{11} = b_{21} = 1$, then equation 14 would become:

$$\ln Q^A = a_0 + (a_1 + a_2) \bullet \ln(ef) + a_3 \bullet \ln(y) + (a_4 + a_5) \bullet \ln(sp) + u - a_1 e_1 - a_5 e_2 \quad (17)$$

The error terms of equations 15 and 16 are included in the error structure of equation 17. If we simultaneously estimate equation 15, 16, and 17 and use the correlation across equations, the efficiency of the estimates should improve.

[5]Note that this specification implicitly assumes that the error structure of the model is multiplicative rather than additive. This assumption means that the slopes rather than the positions of the excess supply and demand functions are random. Turnovsky has shown that the assumption of multiplicative disturbances derives naturally from underlying supply and demand relationships (*8*). His results do not necessarily generalize to the case of *excess* supply and demand functions. For our purposes, however, we simplify the analysis by assuming that the primary source of random variation is from production, to the exclusion of the other sources of consumption and flows into public stocks.

The theoretical model (via equation 11) also maintains that the world price of grain varies directly with the support price and importer income and it varies inversely with exchange rates and target price. Using the same reasoning as in equation 17, we can express this relationship as:

$$\ln(wp) = c_0 + c_1 \cdot \ln(ef) + c_2 \cdot \ln(y) + c_3 \cdot \ln(sp) + z \qquad (18)$$

C_1 is expected to be negative, c_2 is expected to be positive, and c_3 can be either, depending on the strength of relevant elasticities. The error term z includes the effects of e_1 and e_2 of equations 15 and 16, respectively. Because equations 17 and 18 are derived from the same theoretical structure, consideration of cross-equation correlation between them should improve the efficiency of both sets of coefficient estimates.

The export competitor exchange rate was included in equation 17 rather than the importer exchange rate. This choice may be considered arbitrary. Although we report estimation results for both exchange rates, we emphasize the competitor exchange rate for two reasons. First, agricultural economists have ignored the competitor exchange rate (*2*). One of our implicit goals is to redress this omission. Second, as Wilson has noted (*12*), the concern with competitiveness in world grain markets (especially wheat) has emphasized dynamic relationships among the major grain exporters. The choice of which exchange rate to use implicitly recognizes the major source of competition to the United States. The choice of the competitor exchange rate focuses more directly on the export supply responses of major competitors. We will describe importer behavior to the extent that the two exchange rates are collinear.

Estimation Results

We estimate equations 15, 16, 17, and 18 using Zellner's seemingly unrelated regression (SUR) technique for the 1973Q1 to 1985Q4 period for both wheat and feed grains. We chose this period to coincide with the flexible exchange rate period. The volume of U.S. wheat exports, the dollar price, and target and support prices are from various issues of the Economic Research Service's (ERS) *Wheat Situation and Outlook Report (11).* Likewise, U.S. feed grain volume, the dollar price of corn, and target and support prices of corn are from various issues of the *Feed Situation and Outlook Report (10).* A proxy for real world income excluding the United States is calculated from gross national product (GNP) and price data published in various issues of *International Financial Statistics (3).*[6] The importer exchange rate is published in *Agricultural Outlook (9).* It is based on a weighted average of bilateral exchange rates of 38 countries to which the United States exports wheat and corn. Weights are determined by the average of the 1976-78 wheat and corn export shares of each country. The competitors' exchange rate is based on export competitors' share of world wheat and corn exports, excluding the United States, for 1979-81. The major ROW wheat exporters are Canada, France, Argentina, and Australia. The major ROW corn exporters are Argentina, France, the Netherlands, South Africa, and Thailand.[7]

As explained earlier, the exchange rate and domestic policy instruments are expected to affect grain export levels only after a considerable lag. We used both Akaike's (*1, 4*) final predictor error criterion (FPE) and Pagano and Hartley's (*6*) criterion to determine the appropriate lag lengths for the exchange rate and policy variables. We considered a maximum of 12 lags beyond the current period for each explanatory variable.

For wheat, both the FPE and Pagano and Hartley's criteria imply that ROW income should have no lags, whereas the support price and real global exchange rate (ef) should have 12- and 10- period lags, respectively. For feed grains, Pagano and Hartley's test implies that ROW income should have no lags, whereas the support and real global exchange rate (ef) should have 12- and 11-period lags, respectively. The FPE criterion indicates that the optimal lag combination is 12 for the support price and zero for the exchange rate. Although this result seemingly contradicts the hypothesis of long adjustment to exchange rate changes, the FPE value for the combination of 12 lags on both variables is not significantly greater than the minimum FPE given by the case with no lags. Estimation results for the long and zero lag specifications appear below.

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[6]According to the theoretical model, the appropriate income variable should account for changes in economic activity in countries that import grain. However, real income data for those countries are not available on a quarterly basis. As an alternative, a proxy variable has been chosen. It is derived from the unweighted summation of quarterly real GNP levels expressed in 1980 dollars for the following countries: Belgium, Canada, France, Japan, Italy, Netherlands, Sweden, Switzerland, and West Germany. The data for these countries on an annual basis for 1970-82 have been compared to annual real income based on a trade-weighted average of those countries that import U.S. wheat and corn. The contemporaneous correlation between the series is very high, equalling 0.98 and 0.99, respectively. No lag/lead correlation (up to 3 years considered) is ever greater than 0.78. On this basis, we make the assumption that the quarterly series used in this study is an appropriate proxy for studying the effect of rest-of-world income on the demand for U.S. grain.

[7]Both exchange rate series are available from ERS.

The equation results (with standard errors in parentheses) follow.

Wheat

Export Volume:

$$\ln Q^A_t = \underset{(4.24)}{29.45} - \underset{(0.08)}{0.29}\, D1_t - \underset{(0.08)}{0.88}\, D2_t - \underset{(0.08)}{0.10}\, D3_t$$

$$- \underset{(0.32)}{2.45}\, \Sigma \ln ef_{t-i} - \underset{(0.53)}{1.99} \ln y_t + \underset{(0.72)}{3.63}\, \Sigma \ln sp_{t-i} \qquad (19)$$

R^2 = 0.799
SE = 0.18
DW = 1.22

(The Di's are seasonal dummy variables.)

Exchange Rates:

$$\ln ef_t = \underset{(0.33)}{0.42} + \underset{(0.08)}{0.93} \ln em_t \qquad (20)$$

R^2 = 0.736
SE = 0.06

Policy Variables:

$$\ln sp_t = \underset{(0.16)}{0.07} + \underset{(0.13)}{0.74} \ln tp_t \qquad (21)$$

R^2 = 0.396
SE = 0.11

Price:

$$\ln wp_t = \underset{(1.84)}{9.61} - \underset{(0.25)}{0.54} \ln ef_t - \underset{(0.32)}{0.55} \ln y_t - \underset{(0.16)}{1.31} \ln sp_t \qquad (22)$$

R^2 = 0.768
SE = 0.14
DW = 0.96

Export Volume (Using Target Price):

$$\ln Q^A_t = \underset{(4.05)}{7.62} - \underset{(0.08)}{0.40}\, D1_t - \underset{(0.07)}{0.91}\, D2_t - \underset{(0.08)}{0.29}\, D3_t$$

$$- \underset{(0.34)}{2.28}\, \Sigma \ln ef_{t-i} + \underset{(0.58)}{0.76} \ln y_t + \underset{(0.46)}{2.06}\, \Sigma \ln tp_{t-i} \qquad (23)$$

R^2 = 0.761
SE = 0.20
DW = 1.38

Feed Grains

Export Volume (long lag on exchange rate):

$$\ln Q^A_t = \underset{(1.33)}{-16.48} - \underset{(0.07)}{0.01}\, D1_t - \underset{(0.06)}{0.53}\, D2_t - \underset{(0.07)}{0.04}\, D3_t$$

$$- \underset{(0.19)}{1.45}\, \Sigma \ln ef_{t-i} + \underset{(0.23)}{3.43} \ln y_t - \underset{(0.27)}{1.99}\, \Sigma \ln sp_{t-i} \qquad (24)$$

R^2 = 0.85
SE = 0.13
DW = 2.11

Export Volume (zero lag):

$$\ln Q^A_t = \underset{(1.81)}{-16.38} + \underset{(0.07)}{0.06}\, D1_t - \underset{(0.07)}{0.57}\, D2_t + \underset{(0.07)}{0.05}\, D3_t$$

$$- \underset{(0.17)}{1.28} \ln ef_t + \underset{(0.32)}{3.30} \ln y_t - \underset{(0.35)}{1.89}\, \Sigma \ln sp_{t-i} \qquad (25)$$

R^2 = 0.88
SE = 0.11
DW = 1.84

Exchange Rates:

$$\ln ef_t = \underset{(0.42)}{0.12} + \underset{(0.10)}{1.06} \ln em_t \qquad (26)$$

R^2 = 0.576
SE = 0.12

Policy Variables:

$$\ln sp_t = \underset{(0.06)}{-0.04} + \underset{(0.07)}{0.91} \ln tp_t \qquad (27)$$

R^2 = 0.405
SE = 0.10

Price:

$$\ln wp_t = \underset{(0.18)}{-0.59} \ln ef_t + \underset{(0.11)}{0.56} \ln y_t - \underset{(0.19)}{0.78} \ln sp_t \qquad (28)$$

R^2 = 0.243
SE = 0.22
DW = 0.27

Results from equation 19 indicate that a 1-percent change in the effective real exchange rate is accompanied by a mean response of -2.45 percent in the volume of U.S. wheat exports over an 11-quarter period (including the current period). Based on a standard deviation on the coefficent of 0.32, there is a 90-percent probability that the elasticity is between -1.9 and -3.0 for the sample period.

Results from equation 24 indicate that a 1-percent change in the effective real exchange rate is accompanied by a mean response of -1.45 percent in the volume of U.S. feed grain exports over a 12-quarter time horizon. Based on a standard deviation on the coefficient of 0.19, there is a 90-percent probability that the elasticity is between -1.1 and -1.8. Results from the zero lag exchange rate specification indicate a mean response of -1.28 percent with a 90-percent confidence interval between -1.00 and -1.56.

The sign and magnitude of the coefficients in the exchange rate equations (20 and 26) and in the policy variable equations (21 and 27) conform to expectations: the intercept terms are close to zero and the slope coefficients are close to 1. In the price equations (22 and 28), the coefficients on the real exchange rate variable are negative and the absolute values are less than 1, as expected. The signs on the remaining coefficients in both equations are consistent with those in the export volume equations (19, 24, and 25).

The other variables specified in the equations affect grain exports as well. The effect of changes in ROW income on wheat exports is significantly negative: -1.99, with a standard deviation of 0.53. This result is the opposite of what was hypothesized. Barring specification error, this result may indicate a trend toward import substitution during the sample period. This result may also indicate increases in food aid when ROW income decreases. However, when the target price is used as a proxy for domestic policy (equation 23), the sign on the income coefficient is indistinguishable from zero, and the sum of the exchange rate coefficients is close to the value in equation 19. This regression result suggests that the negative sign on the income coefficient may result from collinearity with the policy variable. For feed grain exports, the effect of ROW income is significantly positive as expected: 3.43, with a standard deviation of 0.23.[8]

As for the policy variable, the sum of the support-price coefficients equals 3.63 in the wheat volume equation (19). Recall, a higher support price is expected to reduce U.S. wheat exports. However, a higher target price would be anticipated to increase U.S. wheat supply and thereby partially, fully, or more than offset the effect of the loan rate. With the support-price variables incorporating the effect of target prices, the implication of the positive coefficient sign is that the contribution of the target price to export promotion is greater than the depressing effect of the support price. In equation 23, the target price is included rather than the support price. The lag-length selection criteria indicate 12 lags on the exchange rate, 12 lags on the target price, and zero lags on ROW income. Findings indicate a significantly positive coefficient on the policy variable, although its value (2.18) is smaller. The exchange rate elasticity is about the same for this specification: the 90 percent confidence interval is between -1.70 and -2.86.[9] As mentioned previously, the ROW income coefficient cannot be distinguished from zero.

For the feed grain equation, the sum of the support-price coefficents equals -1.99, with a standard deviation of 0.27. Therefore, support prices have reduced exports more than target prices have expanded them.[10]

Response Time of Exports from Exchange Rate Changes

It is hard to determine when the exchange rate begins to affect grain export volume because of the high degree of collinearity within each exchange rate series. When explanatory variables have linear associations, the estimates of their coefficients generally have large sampling errors. The estimate of a single parameter may be far from its true value as a result. For the exchange rate based on wheat competitors, it is not until the seventh lagged quarter that the correlation with the current value falls below 0.5. For the exchange rate based on feed grain competitors, it is not until the fifth lagged quarter that the correlation with the current value falls below 0.5.

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[8]These income coefficients should not be interpreted as import income elasticities. As shown in equation 12, the coefficient represents the product of the import income elasticity and the U.S. export supply elasticity adjusted by the weighted sum of domestic and foreign net export elasticities. Assuming a fairly elastic U.S. export response to price (which is consistent with the residual supplier hypothesis), the magnitudes of the income response in equations 19, 23, and 24 are not extreme.

[9]We have also estimated the wheat equation including both support and target prices. Pagano and Hartley's procedure indicates that adding one series, given the inclusion of the other, adds nothing to the regression. Nonetheless, we include both series lagged 12 quarters. The sum of both sets of policy coefficients is positive, but cannot be distinguished from zero. The income coefficient is indistinguishable from zero as well. The sum of the exchange rate coefficients, however, is significantly negative (-2.16), with a 90-percent confidence interval of -1.10 to -3.22. Although these results support the exchange rate hypothesis, the specification is not justified on the basis of either the FPE or the Pagano and Hartley's criterion.

[10]A complicating factor for 1981-83 crop years was that the support price for the Farmer-Owned Reserve (FOR) was somewhat higher than the Commodity Credit Corporation (CCC) loan rate. For wheat, the higher support price was effective from 1980Q3 to 1983Q2. For corn, the higher support price was effective from 1980Q4 to1983Q3. We re-estimated the export volume equations incorporating the higher support price series. In this modification, the support-price coefficient for wheat decreased to 2.88 from 3.63 while the support-price coefficient for feed grains decreased in absolute terms to -1.53 from -1.99. In both equations, the sum of the exchange rate coefficients remained approximately the same. For wheat, the sum equaled -2.40 (compared with -2.45), and for feed grains, the sum equaled -1.68 (compared with -1.45). The exchange rate effect is robust across these policy parameters.

One way to treat a multicollinearity problem is to use nonsample information. A commonly used method in lagged times series is placing a polynomial degree restriction on the impact of the variables within the series. This specification assumes that the lag weights within series can be specified by a continuous function, which in turn can be approximated by the evaluation of a polynomial function at discrete points (*7*). The polynomial specification smooths the impact of the exchange rate change on export volume over the lag period, and the degrees of freedom are increased.

We have used Pagano and Hartley's criterion to select the appropriate polynomial degree (*6*). Pagano and Hartley's criterion indicates a first-order polynomial specification for the exchange rate for wheat competitors and a second-order polynomial specification for the exchange rate for feed grain competitors. Tables 1 and 2 show estimation results for the exchange rate coefficients for the wheat and feed grain equations. For wheat, the negative correlation between exchange rate changes and export volume is not evident until the fifth and sixth quarters after the exchange rate change. The effect becomes more negative and significant toward the end of the period. For feed grains, the second-order polynomial specification emphasizes the immediate effect of the exchange rate on export volume. The expected negative effect is strongest in the first year after the exchange rate change.

Table 1—Effect of exchange rate changes on volume of U.S. wheat exports over time

Period	Change in wheat exports due to 1-percent change in exchange rate	Standard deviation
0	0.36	0.19
1	.28	.16
2	.19	.13
3	.11	.10
4	.02	.07
5	–.06	.04
6	–.14	.04
7	–.23	.05
8	–.31	.08
9	–.40	.11
10	–.48	.15
11	–.57	.18
12	–.65	.21

Table 2—Effect of exchange rate changes on volume of U.S. feed grain exports over time

Period	Change in wheat exports due to 1-percent change in exchange rate	Standard deviation
0	–0.36	0.12
1	–.42	.07
2	–.25	.04
3	–.12	.04
4	.01	.05
5	.06	.06
6	.10	.06
7	.11	.05
8	.08	.04
9	.02	.05
10	–.07	.08
11	–.19	.13

Differing Sample Periods

The parameter estimates may be sensitive to the selection of the sample period. We chose 1973-85 to correspond to the flexible exchange rate period and to incorporate the latest available data. Other sample periods could have been used. Table 3 compares 90-percent confidence interval estimates for the wheat and feed grain equations for the following sample periods: 1973Q1-1985Q4 (the base), 1974Q1-1985Q1, 1973Q1-1984Q4, and 1973Q1-1983Q4.

The primary effect of dropping the observations for 1973 is to widen the interval for the income and support-/target-price coefficients in the wheat equation. Otherwise, the interval estimates are fairly close.

Deleting observations for either 1985 or 1984 and 1985 produces more striking results. Except for the income and support-price coefficients in the feed grain equation, the interval estimates become wider. However, the interval in most cases for the base sample falls within the wider bounds of the reduced-size samples. Therefore, the results from the base period cannot be rejected.

The most important feature of including the 1985 observations is the narrowing of the confidence-interval estimates. Although not shown, this narrowing is due to much lower standard errors on the various regression coefficients.

Importer-Based Exchange Rate Measure

The importer exchange rate can be used as a proxy for changes in the value of the dollar instead of the competitor exchange rate. Re-estimation of equations 19, 23, and 24 when em is used instead of ef follow.

Table 3—Parameter interval estimates for differing sample periods[1]

Commodity	Variable coefficient	Sample period	Lower bound	Upper bound
Wheat	ef	1973Q1-1985Q4	-3.00	-1.90
		1974Q1-1985Q4	-3.48	-1.86
		1973Q1-1984Q4	-3.53	.68
		1973Q1-1983Q4	-7.80	-.48
	y	1973Q1-1985Q4	-2.90	-1.08
		1974Q1-1985Q4	-2.25	1.25
		1973Q1-1984Q4	-3.14	1.52
		1973Q1-1983Q4	-6.29	.33
	sp	1973Q1-1985Q4	2.40	4.86
		1974Q1-1985Q4	.77	3.81
		1973Q1-1984Q4	.44	4.62
		1973Q1-1983Q4	1.59	7.83
Wheat	ef	1973Q1-1985Q4	-3.10	-1.24
		1974Q1-1985Q4	-3.63	-1.37
		1973Q1-1984Q4	-1.70	1.02
		1973Q1-1983Q1	-6.72	1.86
	y	1973Q1-1985Q4	-.64	2.08
		1974Q1-1985Q4	-.64	7.22
		1973Q1-1984Q4	-.35	2.53
		1973Q1-1983Q4	-2.11	2.81
	tp	1973Q1-1985Q4	.84	3.36
		1974Q1-1985Q4	-3.17	3.16
		1973Q1-1984Q4	.27	2.63
		1973Q1-1983Q4	.06	4.88
Feed grains	ef	1973Q1-1985Q4	-1.78	-1.12
		1974Q1-1985Q4	-1.92	-1.06
		1973Q1-1984Q4	-1.49	.31
		1973Q1-1983Q4	-2.63	1.01
	y	1973Q1-1985Q4	3.04	3.82
		1974Q1-1985Q4	2.83	4.11
		1973Q1-1984Q4	2.58	3.72
		1973Q1-1983Q4	2.48	4.06
	sp	1973Q1-1985Q4	-2.45	-1.52
		1974Q1-1985Q4	-2.88	-1.18
		1973Q1-1984Q4	-2.46	-1.22
		1973Q1-1983Q4	-2.63	-1.19

[1]Reported at 90-percent confidence interval.

Wheat

Export Volume:

$$\ln Q^A_t = \underset{(10.88)}{53.22} - \underset{(0.13)}{0.37}\, D1_t - \underset{(0.12)}{0.95}\, D2_t - \underset{(0.11)}{0.11}\, D3_t$$

$$- \underset{(0.53)}{2.38}\, \Sigma \ln em_{t-i} - \underset{(1.17)}{4.81} \ln y_t + \underset{(0.56)}{2.05}\, \Sigma \ln sp_{t-i} \qquad (29)$$

R^2 = 0.804
SE = 0.18
DW = 1.29

Export Volume (Using Target Price):

$$\ln Q^A_t = \underset{(7.59)}{25.47} - \underset{(0.11)}{0.30}\, D1_t - \underset{(0.10)}{0.85}\, D2_t - \underset{(0.11)}{0.24}\, D3_t$$

$$-\underset{(0.41)}{1.85}\, \Sigma \ln ef_{t-i} - \underset{(0.88)}{1.68} \ln y_t + \underset{(0.59)}{1.81}\, \Sigma \ln tp_{t-i} \qquad (30)$$

R^2 = 0.813
SE = 0.17
DW = 1.72

Feed Grain

Export Volume:

$$\ln Q^A_t = \underset{(5.07)}{-9.01} + \underset{(0.10)}{0.02}\,D1_t - \underset{(0.11)}{0.60}\,D2_t - \underset{(0.12)}{0.08}\,D3_t$$

$$- \underset{(0.27)}{1.22}\,\Sigma \ln em_{t\text{-}i} + \underset{(0.64)}{2.11}\,\ln y_t + \underset{(0.40)}{0.07}\,\Sigma \ln sp_{t\text{-}i} \qquad (31)$$

$R^2 = 0.813$
SE = 0.14
DW = 1.92

Except for the feed grain support-price variable, the signs on the coefficients in equations 29, 30, and 31 are the same as those for equations 19, 23, and 24. The closeness of the corresponding exchange rate coefficients lends support to the earlier findings.

Conclusions

We have examined changes in grain exports from 1973 to 1985. We introduced a three-country trade model as a framework for analyzing U.S. grain trade, world grain trade, and market price when there are changes in two real effective exchange rates: (1) an exchange rate based on U.S. trade with grain importers and (2) an exchange rate based on global trade of grain competitors. We considered the effects of changes in ROW real income and U.S. target and support prices. The empirical analysis is based on reduced-form equations derived from the structural equations.

The elasticity of U.S. wheat exports with respect to exchange rate changes is between -1.70 and -2.86. This result comes from equation 23 in which the target price is used as the proxy for domestic policy. Other specifications give a similar exchange rate response. All results, as well as those reported below for feed grains, depend on the inclusion of 1985 data. Without 1985 data, the coefficient values have greater variance. The range of confidence regarding the magnitude of the effects has to be wider. Moreover, most of the evidence suggests that exchange rate changes affect wheat exports only over a long lag of 10-12 quarters.

The elasticity of U.S. feed grain exports with respect to exchange rate changes is between -1.10 and -1.80. This result comes from equation 24. Alternative specifications (equations 25 and 31) give roughly the same result. Feed grain estimates for all specifications are in line with theory. These results include the strong positive effect of ROW income and the negative effect of the loan rate. Finally, evidence suggests that most changes in the exchange rate affect exports within the first year of the change in the exchange rate.

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Agricultural Commodity Export Data: Sales and Shipments Contrasted

Fred J. Ruppel

Abstract. Past research has used export shipments as the dependent variable in econometric modeling of international agricultural trade. This article describes export sales data, contrasting sales to shipments, and it provides numerical and statistical measures of the similarity of sales to shipments data. Forward sales are analyzed, together with econometric estimations of the lead/lag relationship between current shipments and current and past values of sales. The two variables are quite different graphically, numerically, and statistically. Thus, one should exercise caution in using shipments data as an economic variable.

Keywords. Exports, export sales, international trade

The U.S. Department of Agriculture (USDA), under Congressional mandate, began to collect data on export sales and export shipments of major U.S. agricultural commodities in late 1973. The motivation for the legislation was the huge, unanticipated Soviet wheat and corn purchases of 1972 and dramatic price increases in U.S. food and feed markets in the months following these Soviet purchases. Exporters of designated agricultural commodities were required to report weekly to USDA's Foreign Agricultural Service, detailing all sales contracted and shipments sent of these commodities, including destinations and intended delivery dates. Large sales (100,000 metric tons or more in 1 day or 200,000 or more metric tons in 1 week) were to be reported by 3 p.m. the next working day. The purpose of the legislation was to provide agricultural commodity markets with more up-to-date information on worldwide demand.

An unintended benefit was the generation of data on commodity export sales. Export sales data allow researchers to model U.S. commodity export transactions more exactly. The decision to buy or sell a commodity generally depends on current economic conditions and on expectations about future needs and conditions. In this context, sales is the *economic* variable, responding to commodity prices, exchange rates, and world income levels. Shipments reflect physical movement of previously sold grain and products (plus small amounts shipped on consignment for further resale) and can be viewed as a *logistical* variable, responding to transportation rates and capacities, weather constraints, and desired delivery dates. In this article, my objectives are: (1) to describe the sales data, with special reference to the contrasts between sales and shipments, (2) to provide numerical and statistical measures of the degree of similarity between sales and shipments data, and (3) to generate econometric estimates of the lead/lag relationships between sales and shipments for corn, soybeans, and wheat.

Researchers have argued for the use of sales data in place of shipments data. Tryfos has asked "whether it is possible to estimate an export demand function using the recorded (historical) exports or imports and price differences. . . because the recorded price difference does not reveal the actual difference which gave rise to observed exports or imports" (*16*, p. 689).[1] Machlup observed that "the statistics of foreign trade record shipments contracted for in the past, while the theory of trade adjustment is concerned with new contracts influenced by new exchange rates. . . to be carried out in the future" (*9*, p. 107). Studies utilizing sales data include work by Heifner, Kahl, and Deaton (*7*), Conklin (*6*), Ruppel (*14*), Ayuk (*1*), Paggi (*13*), and Bessler and Babula (*3*). The first two studies were concerned with pricing efficiency in U.S. grain and soybean markets, the latter two with the impacts of prices and exchange rates on U.S. exports. Heifner, Kahl, and Deaton studied the relationship between large export sales of corn, wheat, and soybeans and futures trading in these commodities, questioning whether insider information of the large trading firms gave them the opportunity to make capital gains before the

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[1]Italicized numbers in parentheses refer to items in the References at the end of this article.

sales were announced (*7*). Conklin used regression analysis and spectral and cross-spectral analysis techniques to test the relationship between Chicago Board of Trade commodity futures prices and export sales data (*6*). Ruppel estimated export demand and stock demand parameters for corn, soybeans, and wheat in two econometric systems, one using shipments data and the other using sales data (*14*). Ayuk performed a similar analysis for cotton (*1*). Using vector autoregression techniques, Paggi (*13*) and Bessler and Babula (*3*) used sales data to assess the impacts of the money supply and exchange rates on U.S. exports.

One can make strong arguments for preferring sales data to shipments data in econometric analyses of commodity demand. The economic, political, and institutional variables at the time of the sale may differ significantly from those at the time of shipment. Results from studies that estimate export parameters using shipments data can be misleading, especially if there is a long lag between sale of the commodity and its actual shipment.

Data Issues in International Agricultural Trade Modeling

Much research in international trade has focused on the impacts of exchange rates and prices on U.S. export demand. These impacts have either been calculated based on a derived expression (Johnson, Grennes, and Thursby (*8*) and Collins, Meyers, and Bredahl (*5*)) or estimated econometrically (Chambers and Just (*4*), Batten and Belongia (2), and Orden (*11*)). Using either method requires data on U.S. exports or export values. The point at issue here is the distinction between export sales and export shipments data. Studies calculating international economic parameters based on a derived expression typically use annual data or an average of a few years' data for export quantity values. However, sales and shipments data differ less drastically over longer periods, so using shipments data in these studies is not problematic.

Studies that use econometric estimation methods to generate international trade parameters generally use either annual or quarterly data. Annual models are rarely able to make use of commodity export sales data because sales data were not available until late 1973 and thus yield too few observations for most econometric work. Models that use quarterly data on U.S. international agricultural trade, however, are not bound by this constraint. It is this group of studies with which I take issue here.

Two frequently cited studies that use quarterly data are Chambers and Just (*4*) and Batten and Belongia (*2*). Chambers and Just "attempt to develop a model. . . which reflects exchange rate effects on the domestic sector as well as the foreign sector of U.S. agriculture" (*4*, p. 33). In the context of a system of equations, Chambers and Just estimate per-capita wheat, corn, and soybean exports (shipments) as functions of lagged dependent variables, current real commodity prices, the Standard Drawing Rights (SDR) to dollar exchange rate, vectors of commodity-specific exogenous shifters, and quarterly dummy variables. Using three-stage least-squares estimators over quarterly data from 1969-I to 1977-II, they conclude that "the estimated structural exchange rate elasticities for exports (all larger than unity) indicate that the level of U.S. grain exports has been very sensitive to fluctuation in the exchange rate" (*4*, p. 38). Chambers and Just have summarized empirical regularities, but have not modeled causal structures. They conclude that, for the period considered, exchange rate changes in a given quarter gave rise to commodity export shipments in the same quarter (because they were regressing current export shipments on current exchange rates). Given the tightness of world grain and soybean markets in 1972-77, it is unlikely that commodity purchases (motivated by exchange rate movements) and commodity shipments could have followed one another so closely. It is more likely that the relationship Chambers and Just find results from equation misspecification and not from economic causality.

Batten and Belongia's declared objective was "to assess the relative impacts of foreign economic activity and real exchange rates on export volume" (*2*, p. 13). They estimated a double-log agricultural export equation in which the real volume of U.S. agricultural exports was estimated as a function of current real foreign gross national product (GNP), a real price index of U.S. agricultural exports lagged twice, and a real trade-weighted index of the foreign exchange value of the U.S. dollar lagged five periods. Batten and Belongia conclude (based on standardized regression coefficients) that "changes in foreign income have been primarily responsible for the changes in foreign demand for U.S. agricultural exports from I/1971 to I/1984" (*2*, p. 13). They implicitly acknowledge a difference between sales and shipments in their attempt to capture the economic component of export transactions by relating values of current shipments to past values of prices and exchange rates. They credit foreign GNP as the primary source of increases and decreases in commodity movements. Their failure to include past foreign GNP values is puzzling, however, because lagged values of other economic variables were included. Even if one accepts their equation specification, their conclusion is questionable because foreign GNP changes do not typically

lead to commodity purchases and ensuing shipments in the same quarter. The use of lagged values as right-hand-side economic variables is a step in the right direction. However, a distributed lag of past export sales would probably predict commodity export values better. This article provides preliminary work toward that end.

Both studies use data on export shipments to construct the dependent variable (*2, 4*). The parameter estimates necessarily reflect changes in the export shipments variables for given changes in right-hand-side economic variables. I maintain that export demand parameter estimates are biased in these representative studies and may be incorrect in other studies that use quarterly export shipments data. The distinction between export sales and export shipments is not trivial, unless sales and shipments are so highly correlated that one variable can be used in empirical estimation as a proxy for the other. If these variables are not highly correlated, incorrect parameter estimates result through econometric misspecification. Ruppel found substantial differences in price and exchange rate impacts on corn exports between systems that included export sales as a dependent variable and systems that used export shipments (*14*). Ayuk found similar results for cotton, with insignificant own-price and exchange rate coefficients, but large differences in foreign GNP and relative price impacts between the models (*1*). When policymakers use incorrect parameter estimates, their policies may be misdirected.

Origin of Export Sales Data

The unanticipated purchase of large amounts of grain by the Soviet Union in 1972 was the catalyst for the generation of data on export sales. Reaction to the "Great Grain Robbery" was dramatic, as food prices rose quickly and reserve grain stocks were depleted. Concern mounted over the unfair advantage of the large grain companies with respect to inside information on future prices and grain trade trends. Therefore, Congress instituted the export sales reporting requirement in the Agriculture and Consumer Protection Act of 1973. The act required the Secretary of Agriculture to set up an export reporting system for agricultural commodities, and it provided for fines up to $25,000 or imprisonment up to 1 year for exporters who knowingly failed to report export sales as required.

The reporting requirement of 1973 continues to generate data on export sales and export shipments. The form that each exporter must submit categorizes new sales for 32 separate commodity classifications plus destination and crop-marketing year of intended delivery.[2] The report includes changes, adjustments, and cancellations of previous sales, purchases of U.S. grain from foreign sellers, and current export shipments. Specific items such as name of buyer, date of sale, exact delivery dates, and selling price and terms, are not requested. Individual reports are confidential. These data are summarized by the Export Sales Reporting Division of the Foreign Agricultural Service. The summary data are published weekly as *U.S. Export Sales (17)* and are available to the public.

Each weekly report provides two sets of summary data. The first lists new sales, purchases of U.S. grain from foreign sellers, buybacks and cancellations, and beginning and ending levels of outstanding export sales (sales that have been contracted but not yet delivered) for the current and next marketing years in addition to current weekly export levels. These summary data are provided for 13 commodities and include two for wheat, five for feed grains, and three for soybeans, as well as aggregate data on rice, cotton, and whole cattle hides. The second set of summary data includes accumulated exports and outstanding export sales for the current and next marketing years, by country of destination. These summary data are provided for 28 commodities and include seven categories of wheat, six of feed grains, three of soybeans, three of cotton, eight of hides, and one of rice.

Nearly all sales of grain and soybeans for export are made by forward contract. The commodity is sold today for delivery sometime in the future. The importer, which may be a private firm or a public agency, first contacts U.S. exporters or multinational grain-trading firms with notice of the intent to purchase a certain quantity of a commodity. These intents are usually advertised publicly, so as to encourage competition among exporters for business and to ensure the most favorable price. However, if the intent to purchase could increase the price of the commodity, business may be conducted in secret, as apparently occurred with the Soviet purchases in 1972 (*10*).

Once details are agreed upon, a contract is drawn up. The sales price may be fixed at some specified amount (flat price contract) or quoted relative to a designated futures price (basis price contract). This futures price changes daily until the associated futures contract is removed from trading. Importers are free to establish the final price at any time prior to delivery date based

[2] The marketing year for each crop begins with the harvest. The marketing year for corn is from September 1 through the following August, for wheat is from June 1 through May, and for soybeans is from September 1 through August. Prior to September 1986 the marketing year for corn was October 1 through the following September. The corn data in this study use the October-September marketing year rather than the September-August marketing year.

on the then-current futures price, and exporters can hedge their own position via futures trading. Contracts also specify quality, shipping arrangements, payment methods, and numerous other details, including penalties for contract cancellation by either party. Shipment may be within the month or may be a year or more away. Seldom is there immediate delivery, except for small amounts that an exporter already owns. In addition to routine buying and selling by major exporters, an export sale usually triggers buying and selling from the farmgate to the loading docks. Although individual transactions become entangled with mass movements of grain, aggregate lags can be detected econometrically.

Relationship Between Export Sales and Shipments

The distinction between export sales and shipments needs to be elaborated. Over a long period, we would presume that export sales and export shipments would be equal. In fact, if we define "net export sales" as gross sales less cancellations, buybacks, and purchases of U.S. grain from foreign sellers, net sales and actual shipments are separated only by the net change in outstanding export sales.

Negative Adjustments to Gross Sales

Contract cancellations and buybacks and purchases of U.S. grain and soybeans from foreign sellers (repurchases) are negative adjustments to gross sales and contribute to the divergence between gross export sales and export shipments. A cancellation is a unilateral action. In contrast, a contract buyback can be initiated by either party and is by mutual consent. Gross sales obviously decrease with contract buybacks and repurchases. Cancellations can be more complex. Some cancellations are simply a matter of how the data are managed. If an importer requests a shipment delay from the current marketing year to the next, this fact appears as both a cancellation for this marketing year and a sale for the next. Net sales are not affected. Loading tolerances on ships have similar effects. A contract quantity is generally stipulated with a plus-or-minus 5-percent margin for different hold capacities and loading techniques. If the ship is underloaded, a cancellation is reported. An overloaded ship likewise increases sales. These situations increase either cancellations or sales when in fact neither was intended to increase or decrease the final amount delivered. Overloading and underloading ships alter net sales, but they would presumably average out to a zero net effect.

Other cancellations are more genuine. Such cancellations can be caused by political, economic, or institutional factors and can be initiated by the buyer, by the seller, or by parties outside the transaction. The simplest case is crop-switching, where an importer requests replacement of one commodity with another. The first crop shows a real cancellation and the second a real sale. The parties adjust prices to cover the new transaction. A second type of real cancellation involves current and expected supplies of a commodity. Buyers may cancel a contract if world supplies of a crop suddenly become more abundant, especially when production of their own country's crop exceeds expected levels. Exporters might cancel if supplies are short or if price goes too high before they have a chance to hedge their orders in existing futures markets. It may be more economical to pay the penalty for contract cancellation than to suffer a severe loss. For the sample period, the largest cancellation was clearly political. The U.S. Government placed an embargo on corn, wheat, and soybeans to the USSR in January 1980 following the Soviet invasion of Afghanistan; 13.8 million metric tons (MMT) of grain were embargoed. This amount exceeded the 8 MMT already committed as part of a 1976 grain trade agreement.

These last types of cancellations create real differences over time between the volume of sales and shipments. However, because of the way the data are compiled, it is impossible to separate out the real cancellations. It is likewise impossible to tell what percentage of the total level of sales constitutes real sales (that is, excluding sales increases from loading tolerances and marketing year switches). If a period were chosen such that beginning and ending outstanding export sales were equal, the difference between total sales and total shipments would be the amount of total cancellations. The figure for real cancellations would be much smaller, as would be the figure for real sales. Because isolating real cancellations and sales from their total amounts is impossible, I will use the level of "net export sales." As already explained, net export sales equals total export sales minus cancellations, buybacks, and purchases of U.S. grain from foreign sellers. The volume of net export sales over time will differ from the volume of export shipments only by the difference between beginning and ending levels of outstanding sales.

Outstanding Export Sales

Outstanding export sales represent sales that have been contracted, but not yet delivered. The level increases as new sales are made, and it decreases as exports are shipped. These levels fluctuate with market conditions and importers' expectations. In a tight market with further expectations of short supply, buyers tend to increase their purchases for later export

to ensure availability of grain for later consumption. When grain is readily available, buyers are far less concerned with contracts for future delivery, and the level of outstanding sales is low. Over a given period, the data may show large or small differences between total sales and total shipments, depending on beginning and ending levels of outstanding sales.

One might question the importance of outstanding sales in terms of quantity magnitudes. In figure 1, panel A, beginning levels of quarterly outstanding export sales of corn, soybeans, and wheat are plotted over time, by marketing quarters from 1974 through 1985. The circled observations represent the first quarter of the marketing year for each crop. We would generally expect high levels of outstanding export sales going into each new marketing year. Corn and soybean levels are consistent with this expectation, with outstanding sales levels generally highest in the first quarter of the crop-marketing year. Outstanding wheat sales, however, are typically *lower* in the first quarter of the marketing year (June-August) than in any other quarter. These figures are more revealing when they are compared with actual shipment levels. From 1974 to 1985, quarterly beginning levels of outstanding export sales of corn averaged 13.9 MMT, with a minimum of 5.4 MMT and a maximum of 27.8 MMT. Actual shipments during this time period averaged only 11.9 MMT. Outstanding sales of soybeans averaged 5.8 MMT (ranging from 1.4 to 17.2 MMT), with actual shipments averaging 4.9 MMT. Outstanding sales of wheat averaged 8.9 MMT (ranging from 3.5 to 15.0 MMT), with actual shipments averaging 8.3 MMT. The average beginning level of outstanding sales was greater for each commodity than the average quantity shipped per quarter.

Figure 1, panel B, illustrates the link between beginning levels of outstanding sales and actual shipments, where the ratios of beginning (quarterly) outstanding sales levels to actual quantities shipped during the ensuing quarter are plotted over time. The circled observations again reflect the first quarter of the marketing year. Note the number of ratio values greater than unity. A ratio value greater than 1.0 indicates that forward sales had to have been contracted for delivery durations longer than one quarter. Increasingly greater ratio values necessarily indicate longer and longer lag lengths between commodity sale and shipment. The mean ratio value was 1.22 for corn, 1.33 for soybeans, and 1.11 for wheat. Furthermore, the ratio values for each crop seldom drop below 0.75, and on only one occasion for all three crops does the ratio drop below 0.50. That is, in almost every crop quarter, at least 50-75 percent of crop shipments that quarter had been sold prior to the beginning of the quarter. This result demonstrates the potential significance of lead/lag relationships between sales and shipments.

Finally, figure 1, panel B, demonstrates both the positive serial correlation in corn and soybean ratio values from quarter to quarter and the positive first-order and negative second-order serial correlation for wheat. These corn and soybean results are not unexpected, as the numerator is a stock variable that would be expected to exhibit positive serial correlation. The wheat result, however, is surprising and highlights the tremendous seasonality in outstanding export sales levels of wheat. The consistently low levels of outstanding export sales at the beginning of the marketing year relative to other quarters (fig. 1, panel A) lead to these low ratio values at the beginning of the wheat marketing year. There are two possible explanations for this phenomenon. The first involves wheat production in the Southern Hemisphere. The May-July harvest of North American wheat overlaps the Southern Hemisphere's wheat marketing year, where wheat is typically harvested in November-January. At the time of the U.S. harvest, other wheat is still available for purchase, and importers have a choice of old-crop Southern Hemisphere wheat or new-crop Northern Hemisphere wheat. They can easily buy on cash markets for delivery in the near future, leaving outstanding export sales of wheat low during this period. The second possible explanation involves wheat's competition with corn and soybeans for vessel space. That is, importers of U.S. wheat find it unnecessary to contract ahead for delivery during the Northern Hemisphere summer months, but must compete for vessel space following corn and soybean harvests. Corn and soybean ratio values exhibit far less seasonality.

Numerical Comparisons from Annual Data

Net export sales for any chosen period can be calculated from data on outstanding export sales and accumulated export shipments. The ending level of outstanding export sales (OS) is equal to the beginning level plus the (positive or negative) excess of net new sales (SA) over current shipments (SH):

$$OS_t = OS_{t-1} + (SA_t - SH_t) \quad (1)$$

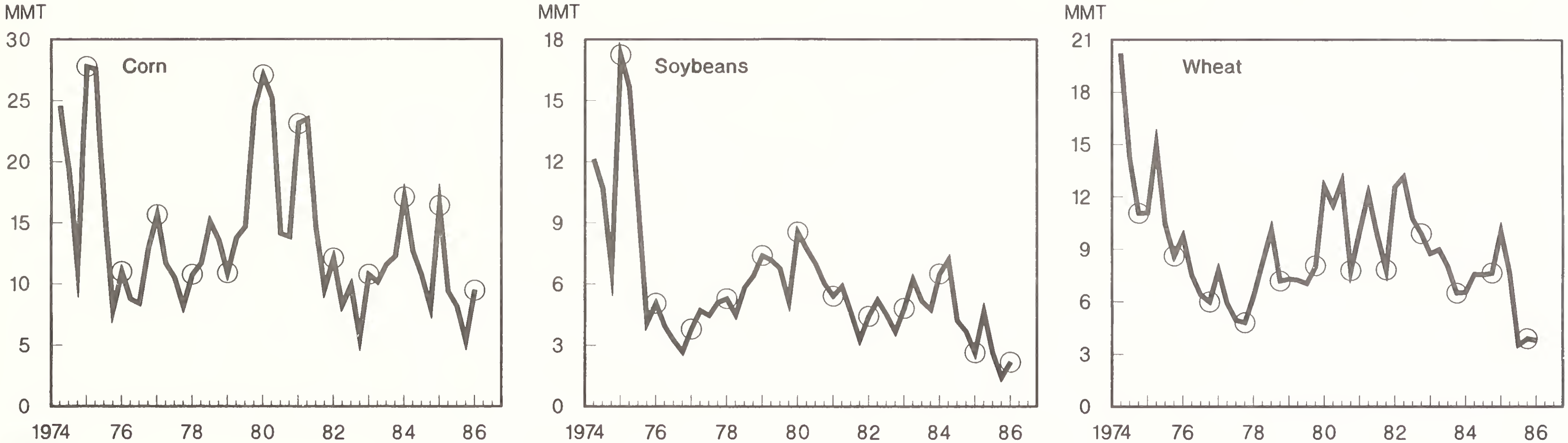
Net new sales for a given period can thus be calculated as the increase or decrease in outstanding export sales during the period, plus current shipments:

$$SA_t = (OS_t - OS_{t-1}) + SH_t \quad (2)$$

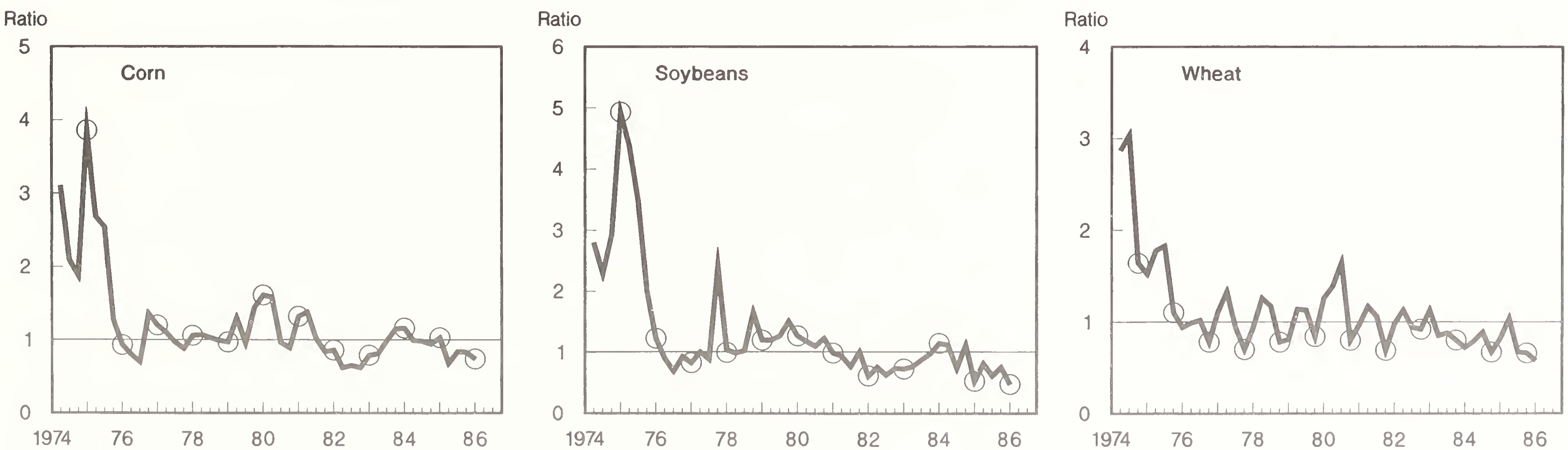
Sales can be stipulated for delivery in either the current marketing year (OSC) or the next year (OSN), and

Figure 1
Outstanding export sales of corn, soybeans, and wheat

Panel A: Outstanding export sales levels



Panel B: Ratios of beginning outstanding export sales levels to ensuing shipments



MMT = million metric tons.

outstanding sales records are kept for both. Shipments are calculated as the difference between two levels of accumulated export shipments (AE). Hence:

$$SA_t = [(OSC_t + OSN_t) - (OSC_{t-1} + OSN_{t-1})] + (AE_t - AE_{t-1}) \quad (3)$$

where SA_t refers to overall net new export sales regardless of marketing year of intended delivery.[3]

The shorter the time frame, the greater the relative divergence between export shipments and net export sales will be. Since most grain is generally shipped within 4-6 months from the time it is purchased, it might seem that annual data on export sales and shipments would be approximately equal. Table 1 shows calendar-year and marketing-year annual shipment and net sales data for corn, soybeans, and wheat for 1974-85. Although the mean values of sales and shipments in both calendar-year and marketing-year calculations are approximately equal for each crop, the individual data values for each year differ greatly. In only 5 of 69 separate pairs of data points is the deviation between sales shipments less than 1 percent (table 1). In 40 cases (58 percent), the deviation between the two pairs of points is greater than 5 percent. More than 50 percent of the cases where the pairs of points differ by less than 5 percent occurred after 1981, a period when large grain and soybean stocks presumably made forward sales less necessary.

The correlation coefficients for each of the six sets of annual data are positive and reasonably large, pointing to strong relationships between the variables, but that relationship is greater than 0.90 only for wheat. One would hope to see values closer to unity to qualify one variable as a "proxy variable" for the other or to argue for small amounts of "measurement error." It is interesting that the correlation coefficient between the two wheat variables is larger with marketing-year data than with calendar-year data. Marketing-year data for sales and shipments should differ if there are significant lag relationships between the two variables. The strong relationship in wheat marketing-year sales and shipment data again indicates less forward sales activity for wheat between marketing years. The low figures for calendar-year 1975 and marketing-year 1974/75 soybean sales were the result of extremely high importer purchases just prior to the 1974 U.S. soybean harvest. Worldwide soybean supplies were anticipated to be extremely tight because of a Brazilian ban on soybean and soymeal exports. The lifting of the ban in November led to the cancellation of many prior purchases of U.S. soybeans in later quarters (*12*, pp. 7-8).

Table 1 reflects annual data, where we would have expected large divergences between the two variables to have been smoothed out. A shorter period shows far weaker relationships between sales and shipments. If one uses quarterly data over the same period, the correlation coefficients between corn and soybean export sales and export shipments are 0.36 and 0.59, respectively. Wheat sales and shipments are more highly correlated, at 0.71. Even if one could argue from the annual data that the sales and shipment data do not differ significantly, one cannot draw the same conclusion from quarterly data.

Graphic Analysis from Quarterly Data

Simple graphs of sales and shipments over time reveal important aspects of the sales/shipments relationship. Figure 2 plots quarterly export sales and export shipments of corn, soybeans, and wheat from 1974-85. Two points emerge. First, the sales data are much more variable than the export data. The export data for all three commodities track relatively smoothly over time, but the sales data are much more spiked. The coefficients of variation for quarterly corn, soybean, and wheat sales are 0.47, 0.40, and 0.53, whereas the coefficients of variation of their shipments are 0.26, 0.25, and 0.30, respectively. Second, a pattern of seasonal variation emerges. The circled observations represent end-of-marketing-year (fourth-quarter) data. Export shipments for all three commodities are consistently and substantially lower in the fourth marketing quarter than in the earlier three, with corn and soybean export sales generally higher in the fourth quarter. This fourth-quarter-sales/first-quarter-shipments observation again points to the potential importance of lags between sales and shipments.

Econometric Analysis of the Lag Relationship

The total amount of exports shipped must over time equal the sum of all past net sales. Thus, current export shipments can be represented as a distributed lag of past values of net export sales. Tables 2 and 3 show the results of an econometric investigation into the lag relationships between export sales and export shipments of corn, soybeans, wheat, and hard red winter (HRW) wheat.[4] The columns of table 2 are in two categories. The first two columns are corn equations,

[3]There are problems inherent in converting weekly data to monthly, quarterly, or annual figures. Please contact the author for specific procedures used to generate quarterly and annual sales and shipments data from weekly publications.

[4]Because HRW wheat accounts for approximately 50 percent of all U.S. wheat grown and exported, where regression results are reported, separate equations are reported for HRW wheat as well as for aggregate wheat.

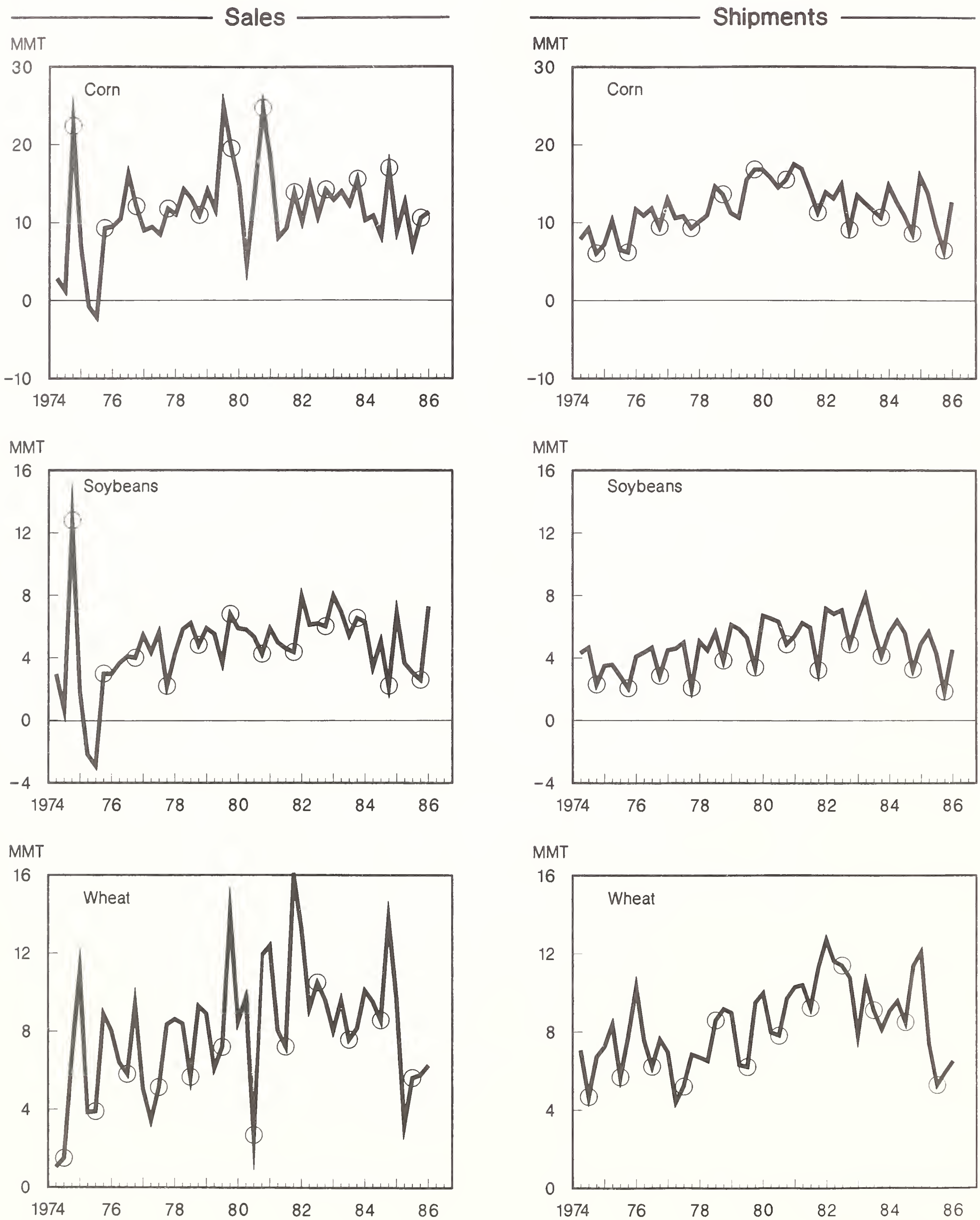
Table 1—Export sales and export shipments of corn, soybeans, and wheat: Annual data by calendar and marketing years

Item	Corn		Soybeans		Wheat	
	Sales	Shipments	Sales	Shipments	Sales	Shipments
	1,000 metric tons					
Calendar year:						
1974	33,454	30,419	18,320	14,792	20,425	25,674
1975	15,880	34,695	854	12,551	24,711	32,173
1976	48,089	45,210	17,209	* 16,413	26,751	28,366
1977	40,848	** 40,787	16,569	* 16,809	25,563	23,203
1978	52,573	* 50,398	22,812	20,124	32,291	* 33,305
1979	71,196	59,852	21,919	* 21,376	35,940	32,027
1980	61,787	* 63,481	21,315	23,148	36,845	* 35,799
1981	41,303	56,561	21,919	* 22,594	44,586	* 43,621
1982	52,699	* 50,804	26,367	* 25,349	37,391	41,558
1983	52,116	* 49,625	25,255	* 24,293	35,446	* 36,846
1984	44,976	48,247	17,642	20,185	41,583	** 41,516
1985	41,309	* 42,550	16,618	* 16,338	20,917	24,999
Mean	46,353	47,719	18,900	19,498	31,871	33,257
Standard deviation	13,976	9,744	6,582	4,064	8,028	6,857
	Ratio					
Coefficient of variation	0.302	0.204	0.348	0.208	0.252	0.206
	Statistical measure					
Correlation coefficient	0.82		0.84		0.91	
	1,000 metric tons					
Marketing year:						
1974/75	13,355	30,140	–238	11,957	25,627	28,046
1975/76	48,595	43,942	14,729	15,980	29,231	31,882
1976/77	38,788	43,669	17,765	16,275	23,069	* 24,222
1977/78	49,450	** 49,289	21,162	19,054	31,039	28,690
1978/79	70,451	54,283	21,936	20,789	31,529	30,707
1979/80	58,837	62,768	21,314	24,457	35,058	** 35,283
1980/81	49,070	60,109	19,855	* 20,844	39,684	** 39,631
1981/82	49,896	* 51,253	26,330	* 25,935	49,049	* 46,976
1982/83	54,764	48,369	26,937	25,244	34,851	38,251
1983/84	46,362	* 47,047	17,039	20,900	36,373	* 35,223
1984/85	38,877	45,886	16,270	* 16,730	32,363	36,110
Mean	47,131	48,796	18,464	19,833	33,443	34,093
Standard deviation	14,273	8,770	7,308	4,367	7,019	6,326
	Ratio					
Coefficient of variation	0.303	0.180	0.396	0.220	0.210	0.186
	Statistical measure					
Correlation coefficient	0.81		0.87		0.95	

Note: Double asterisks (**) denote less than 1-percent differences, and asterisks (*) denote less than 5-percent differences between pairs of numbers.

Figure 2

Export sales and export shipments of corn, soybeans, and wheat



MMT = million metric tons.

Table 2—Corn, soybeans, wheat, and hard red winter (HRW) wheat: Lagged export sales as predictors of export shipment levels

Equation	Corn (1)	Corn (2)	Soybeans (3)	Wheat (4)	HRW wheat (5)
			Coefficient		
nXS	0.18 (2.26)	0.14 (2.03)	0.21 (3.22)	0.35 (5.08)	0.29 (4.45)
nXS1	.41 (5.04)	.31 (4.44)	.23 (3.49)	.41 (5.98)	.41 (6.21)
nXS2	.20 (2.99)	.09 (1.45)	.05 (1.10)	.10 (1.39)	.10 (1.42)
nXS3	.16 (2.48)	.06 (1.05)	.06 (1.38)	.05 (.74)	.04 (.61)
nXS4	.06 (.92)	.06 (1.08)	.08 (1.75)	.03 (.40)	.11 (1.64)
[LAG SUM]	[1.01]	[.66]	[.63]	[.94]	[.95]
CROP QTR1	—	2,698 (3.33)	1,789 (6.06)	365 (.55)	–477 (1.14)
CROP QTR2	—	2,444 (2.76)	2,101 (7.18)	–292 (.43)	–1,226 (2.99)
CROP QTR3	—	2,408 (2.84)	1,962 (6.97)	–441 (.76)	–177 (.46)
INTERCEPT	—	2,533 (1.95)	620 (1.63)	853 (1.04)	705 (1.31)
R-SQUARE	—	.71	.84	.81	.73
ADJ-R-SQ	—	.65	.81	.77	.66
Durbin-Watson statistic	1.45	1.51	1.60	1.56	1.73
Degrees of freedom	39	35	35	35	31

Note: The variables denoted by "nXSi" are current and lagged values of export sales, where n indicates the commodity (C, S, W, H) and i indicates the lag length (0-4). For each equation, the dependent variable is export shipments per quarter, and the summation of the coefficients on current and lagged sales and outstanding sales is reported in brackets. Absolute values of t-statistics are reported in parentheses. The R^2 statistic is invalid in the first equation.

— = Not applicable.

with different equation structures in each column. The last three columns are soybean, wheat, and HRW wheat equations, with structures identical to the second corn equation. The dependent variable in all five equations is export shipments per quarter measured in 1,000 metric tons. All the equations were estimated by ordinary-least-squares over crop-marketing quarter data from 1974 through 1985. Because the first year of data provides lag values for 1975, there were 44 observations over each of the commodities, except for HRW wheat, where 1974 data were not available. Summary statistics (where appropriate) are provided in the last rows of each column.

The first equation shows export shipments of corn (nXD interpreted as CXD) as a function of current (nXS) and four quarterly lagged values of export sales (nXS1-nXS4). The intercept is suppressed so that the coefficients on the right-hand-side variables can be interpreted as percentages. That is, export shipments in any given quarter are made up of the sum of percentages of sales from current and previous quarters. Because the average magnitude of each variable on the right side of the equation is approximately equal to the mean of the dependent variable, if the lag structure encompasses the entire realm of forward sales activity (or the greater portion thereof), the

Table 3—Corn, soybeans, wheat, and hard red winter (HRW) wheat: Current and lagged export sales and lagged beginning outstanding sales as predictors of export shipment levels

Equation	Corn		Soybeans		Wheat		HRW wheat	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
	Coefficient							
nXS0	0.21 (3.91)	0.18 (3.36)	0.34 (5.55)	0.32 (6.16)	0.36 (6.38)	0.35 (5.77)	0.28 (4.66)	.027 (4.23)
nXS1	.35 (6.78)	.34 (5.65)	.31 (5.70)	.31 (5.73)	.40 (7.11)	.40 (6.45)	.42 (6.90)	.42 (6.26)
nXS2	—	.13 (2.48)	—	.13 (3.38)	—	.11 (1.81)	—	.11 (1.64)
nOS1/nOS2	.20 (4.88)	.17 (3.87)	.17 (4.02)	.20 (5.11)	.23 (4.08)	.16 (2.81)	.20 (3.12)	.12 (1.70)
[LAG SUM]	[.76]	[.82]	[.82]	[.96]	[.99]	[1.02]	[.90]	[.92]
CROP QTR1	2,745 (4.08)	2,771 (3.95)	1,693 (6.40)	1,830 (7.64)	426 (.96)	421 (.85)	–64 (.20)	–177 (.51)
CROP QTR2	1,889 (2.83)	2,495 (3.36)	1,659 (6.26)	2,146 (9.20)	–142 (.32)	–132 (.26)	–810 (2.45)	–961 (2.71)
CROP QTR3	2,235 (3.53)	2,159 (3.26)	1,679 (6.64)	1,782 (7.92)	–508 (1.34)	–380 (.91)	–5 (.02)	–7 (.02)
INTERCEPT	1,234 (1.12)	376 (.29)	–261 (.55)	–1,185 (2.27)	273 (.42)	–8 (.01)	552 (1.19)	589 (1.04)
R-SQUARE	.79	.78	.86	.89	.86	.84	.75	.72
ADJ-R-SQ	.75	.73	.84	.87	.83	.81	.70	.66
Durbin-Watson statistic	1.84	1.97	2.15	2.33	1.94	2.01	1.73	1.84
Degrees of freedom	37	36	37	36	37	36	33	32

Note: The variables denoted by "nXSi" are current and lagged values of export sales, where n indicates the commodity (C, S, W, H) and i indicates the lag length (0-4). The variables denoted by "nOS1/nOS2" are lagged beginning outstanding sales levels by commodity (n) and by lag length (1 or 2 as appropriate). For each equation, the dependent variable is export shipments per quarter, and the summation of the coefficients on current and lagged sales and outstanding sales is reported in brackets. Absolute values of t-statistics are reported in parentheses.
— = Not applicable.

coefficients should sum to approximately 1.0. The coefficient on each current and lagged sales variable reflects the percentage of current export shipments that was sold i periods ago, with i taking on a value from zero to 4. The first equation reveals that, on average, 18 percent of current export shipments of corn were sold during the current quarter, 41 percent during the previous quarter, 20 percent two quarters ago, and 22 percent three or four quarters ago. For each equation in tables 2 and 3, the number in brackets following the four-lag coefficient and associated t-statistic is the sum of the coefficients on the current and lagged sales variables for that equation. In this first corn equation, the sum of the lag coefficients of 1.01 yields the expected result. The comparable soybean, wheat, and HRW wheat equations (not shown) have coefficients summing to 1.01, 1.02, and 1.00 with associated coefficients of 0.35, 0.30, 0.19, 0.08, 0.10; 0.39, 0.38, 0.10, 0.10, 0.05, and 0.27, 0.36, 0.23, 0.08, and 0.06, respectively. The suppression of the intercept means that the R^2 statistic (the coefficient of multiple determination) is not valid.

Quarterly dummy variables for the first three quarters of the marketing year and an intercept term are added in the second corn equation and in the soybean, wheat, and HRW wheat equations of columns 3, 4, and 5 (table 2). With the intercept and dummy variables added, the coefficients on current and lagged sales can no longer be interpreted as percentages summing to 1.0. The literal values on the lag coefficients are no longer meaningful. Rather, the *positive* magnitudes of these (within-equation) coefficients relative to one another become important, with significance on the coefficients interpreted only in a one-tail sense. The sum of the coefficients drops to 0.66 in the corn equation, and it drops to 0.63, 0.94, and 0.95 in the soybean, wheat, and HRW equations, respectively.

A problem with the equations of table 2 lies in the general insignificance of coefficients beyond the first lag quarter. Dropping the more distant lags from the estimation is not the proper way to handle this problem, because the lag structure for all the commodities clearly reaches further back than one quarter. An alternative method of assessing the lag relationship is to replace sales in the more distant quarters with the level of beginning outstanding sales for a more recent quarter.[5] That is, if one lagged sales variable is to be included in the equation, the two-, three-, and four-lag sales variables are replaced by the level of beginning outstanding sales in the previous period. Thus, the lagged beginning outstanding sales variable reflects sales contracted in two or more earlier periods, but not yet shipped at the beginning of the previous quarter. Table 3 shows the results of this equation specification for lag lengths of one and two sales quarters and for beginning outstanding sales levels lagged one and two periods, respectively.

The equations in table 3 differ noticeably from those in columns 2-5 of table 2. The adjusted R^2 improves an average of 0.06 in the one-lag specification and 0.045 in the two-lag specification. The sums of the significant coefficients move closer to 1.0, and the Durbin-Watson statistics move closer to 2.0. The quarterly dummy variables remain positive and significant in the corn and soybean equations, but are generally insignificant in the wheat equations. Nearly all the coefficients on the current and lagged sales and outstanding sales variables are significant at the 5-percent level, and the remainder are significant at the 10-percent level. For each commodity, the coefficients on both the current sales variable and the one-lag sales variable are larger than each of the corresponding coefficients on the two-lag sales variable and the lagged beginning outstanding sales variable, indicating the greater impact of more recent sales on current shipments. None of the intercepts is significant, except for the two-lag specification of the soybean equation.

[5]Thanks for this alternative specification are due to an insightful anonymous reviewer who looked unfavorably on the practice of summing coefficients not significantly different from zero.

Analysis of Marketing-Quarter-Specific Lead/Lag Relationships

The equations in tables 2 and 3 are limited in revealing the lead/lag relationships between export sales and export shipments of corn, soybeans, wheat, and HRW wheat. Simply lagging the sales data falls short for two reasons. First, the lead/lag relationship is likely to differ for each marketing quarter. Shipments made in the first quarter of the marketing year are not likely to have had the same sales lag structure as shipments made in the third quarter. Both the beginning outstanding sales levels and the ratios of beginning outstanding sales to ensuing shipments vary by marketing quarter for each commodity.

Second, the sales means are different for each quarter. When equations are estimated econometrically, deviations from the means of the right-hand-side variables are plotted against deviations from the means of the dependent variable. The estimated equations in tables 2 and 3 use aggregate means for the sales variables for all quarters, when these values actually differ for each quarter. Quarter-specific, right-hand-side variables are more desirable, as deviations from the mean during the first marketing quarter, for example, would be deviated from a mean associated with that quarter.

Table 4 presents an alternative econometric analysis of the lead/lag relationship between export sales and export shipments. The right-hand-side variables used in the estimation are [0,x] interactive dummy variables, obtained by multiplying a [0,1] value for each of four quarters by the appropriate lagged value of sales or beginning outstanding sales. The column headings represent the shipment quarter, and the row designations reflect the lag length. The sales quarter can be inferred from these two components. That is, cell QTR1/CLAG1 (denoted C-Q1L1) represents corn sales contracted in the fourth marketing quarter, one lag period prior to the first shipment quarter. This variable receives a value only once four observations, when the CROP QTR1 value of 1 (from tables 2 and 3) is multiplied by the lagged sales value. In similar fashion, cell QTR2/WLAG0 (W-Q2L0) represents wheat sales contracted in the second marketing

Table 4—Export shipments as a function of quarter-specific current and lagged export sales and lagged beginning outstanding sales

Item	Unit	QTR1	QTR2	QTR3	QTR4	Function
Corn:						
CLAGO	Coefficients	0.32	0.36	0.25	0.14	—
		(1.75)	(3.35)	(2.88)	(1.08)	—
		[.08]	[.07]	[.06]	[.04]	—
	Quarters	(1)	(2)	(3)	(4)	—
CLAG1	Coefficients	.63	.29	.51	.35	
		(4.31)	(1.70)	(5.29)	(3.85)	—
		[.19]	[.07]	[.10]	[.08]	—
	Quarters	(4)	(1)	(2)	(3)	—
CBOS1	Coefficients	.03	.34	.30	.40	—
		(.29)	(4.61)	(7.23)	(3.43)	—
		[.01]	[.12]	[.09]	[.10]	—
	Quarters	(3,2,1)	(4,3,2)	(1,4,3)	(2,1,4)	—
Statistics:						
"R-Square"	—	—	—	—	—	.79
Durbin-Watson	—	—	—	—	—	2.12
Degrees of freedom	—	—	—	—	—	32
Soybeans:						
SLAGO	Coefficients	.51	.21	.54	.29	—
		(6.39)	(1.83)	(3.16)	(2.32)	—
		[.16]	[.05]	[.11]	[.06]	—
	Quarters	(1)	(2)	(3)	(4)	—
SLAG1	Coefficients	.21	.66	.22	.27	—
		(1.62)	(5.74)	(1.23)	(3.79)	—
		[.04]	[.18]	[.05]	[.06]	—
	Quarters	(4)	(1)	(2)	(3)	—
SBOS1	Coefficients	.36	.17	.31	.19	—
		(3.44)	(4.59)	(10.09)	(2.64)	—
		[.08]	[.05]	[.10]	[.05]	—
	Quarters	(3,2,1)	(4,3,2)	(1,4,3)	(2,1,4)	—
Statistics:						
"R-Square"	—	—	—	—	—	0.89
Durbin-Watson	—	—	—	—	—	2.39
Degrees of freedom	—	—	—	—	—	32

See notes at end of table.

—Continued

Table 4—Export shipments as a function of quarter-specific current and lagged export sales and lagged beginning outstanding sales (Continued)

Item	Unit	QTR1	QTR2	QTR3	QTR4	Function
Wheat:						
WLAGO	Coefficients	.35	.37	.36	.36	—
		(3.67)	(2.70)	(3.41)	(2.98)	—
		[.11]	[.10]	[.07]	[.07]	—
	Quarters	(1)	(2)	(3)	(4)	—
WLAG1	Coefficients	0.39	0.35	0.50	0.49	—
		(3.57)	(2.75)	(3.76)	(4.17)	—
		[.07]	[.11]	[.14]	[.10]	—
	Quarters	(4)	(1)	(2)	(3)	—
WBOS1	Coefficients	.32	.30	.11	.19	—
		(3.38)	(1.87)	(.88)	(2.64)	—
		[.08]	[.06]	[.03]	[.05]	—
	Quarters	(3,2,1)	(4,3,2)	(1,4,3)	(2,1,4)	—
Statistics:						
"R-Square"	—	—	—	—	—	0.86
Durbin-Watson	—	—	—	—	—	1.98
Degrees of freedom	—	—	—	—	—	32
HRW Wheat:						
HLAG0	Coefficients	.33	.23	.27	.26	—
		(3.92)	(1.92)	(2.52)	(2.61)	—
		[.11]	[.06]	[.06]	[.04]	—
	Quarters	(1)	(2)	(3)	(4)	—
HLAG1	Coefficients	.34	.32	.78	.44	—
		(3.01)	(3.22)	(7.03)	(3.72)	—
		[.06]	[.11]	[.22]	[.09]	—
	Quarters	(4)	(1)	(2)	(3)	—
HBOS1	Coefficients	.29	.38	–.02	.31	—
		(3.91)	(1.57)	(.18)	(4.20)	—
		[.08]	[.07]	[.00]	[.10]	—
	Quarters	(3,2,1)	(4,3,2)	(1,4,3)	(2,1,4)	—
Statistics:						
"R-Square"	—	—	—	—	—	.84
Durbin-Watson	—	—	—	—	—	1.72
Degrees of freedom	—	—	—	—	—	28

Note: The blocks denoted by "nLAGi" represent current and lagged values of export sales, where n indicates the commodity (C, S, W, H) and i indicates the lag length (0-1). The blocks denoted by "nBOS1" are lagged beginning outstanding sales levels by commodity (n). For each equation, the dependent variable is export shipments per quarter. Absolute values of t-statistics are in parentheses; means-adjusted coefficients (elasticities) are in brackets; and sales quarters are in parentheses "R-Square" is the square of the correlation coefficient between the actual and predicted value of the dependent variable.

— = Not applicable.

quarter, zero lag periods prior to the second (shipment) quarter, and QTR4/SBOS1 (S-Q4B1) represents beginning outstanding soybean sales in the third crop quarter, one lag period prior to the fourth shipment quarter. Again, the level of beginning outstanding sales in a given marketing quarter reflects sales contracted either in a prior quarter of the current marketing year or in the previous marketing year, but not yet shipped as of the beginning of the quarter.

Corn, soybean, wheat, and HRW wheat export shipments were regressed on the interactive variables already described, with the results presented in table 4. Each equation contains 12 regressors (4 quarters by 3 lagged sales variables: current sales, lagged sales, and lagged beginning outstanding sales), with the intercept suppressed for each commodity. For each regressor, the estimated coefficent is given, with the absolute value of the t-statistic in parentheses, the means-adjusted coefficient (elasticity) in brackets, and the crop-marketing quarter in which the sale was made in parentheses. For the nBOS1 variables,this last line lists the three most recent quarters for which sales contracted in one of those quarters would likely have been included in beginning outstanding sales. Summary statistics are reported for each commodity. As noted earlier, the R^2 statistic is invalid. Instead, what is reported as "R^2" is the correlation coefficient between the actual and predicted values of the dependent variable. This statistic is identical to R^2 in ordinary-least-squares (OLS) equation estimation. The "R^2" values in the equations in table 4 are similar to the R^2 statistics of table 3, except for HRW wheat where the explanatory power improves substantially.

Of the 48 current and lagged coefficients for the four commodities, 41 are significant at the 5-percent level (one-tail), and three others are significant at the 10-percent level. The estimated coefficients for each commodity sum to approximately 4.0, and the means-adjusted coefficients sum to approximately 1.0. Because of large differences in quarterly sales means, the literal coefficients are less meaningful than are the means-adjusted coefficients; these latter coefficients measure the percentage of total shipments attributable to a given lag structure. The commodities can be analyzed vertically by shipment quarter, horizontally by lag length, and diagonally by sales quarter.

The largest means-adjusted coefficients in the corn equation are C-Q1L1, a fourth-quarter-sales/first-quarter-shipments lag structure, and C-Q2B1, beginning outstanding sales in the first marketing quarter reflecting sales in the fourth, third, and second marketing quarters. We see nearly a third of total shipments explained by these two lag structures. When means-adjusted coefficients are added horizontally, 44 percent of total shipments have a one-quarter lag, and another 32 percent have lags extending beyond one quarter. Three of the five largest means-adjusted coefficients are in the CBOS1 row, indicating the importance of these longer lags to second-, third-, and fourth-quarter corn shipments. First-quarter shipments typically reflect only first-quarter and fourth-quarter sales.

Whereas fourth-quarter sales are important in corn export marketing, first-quarter sales are important for soybeans. Three of the four largest means-adjusted coefficients in the soybean block are S-Q1L0, S-Q2L1, and S-Q3B1, all reflecting (either exclusively or principally) sales contracted in the first marketing quarter. These three lag structures comprise 44 percent of total shipments. Concurrent sales and shipments are more common for soybeans than for corn, with 38 percent of total soybean shipments having a zero lag length compared with 25 percent for corn. Finally, adding vertically, we see fourth-quarter shipments to be low relative to the other three quarters, confirming the regularities we noted in soybean shipments (fig. 2).

The two wheat equations need to be examined jointly because the all-wheat results are largely determined by HRW wheat. The most significant finding is the short lag structure for wheat shipments. Nearly 50 percent of total HRW wheat shipments have a one-quarter lag structure, with H-Q3L1 and H-Q2L1 having the two largest means-adjusted coefficients. Only 25 percent of HRW shipments are associated with sales contracted two or more quarters past. The all-wheat numbers are slightly smaller in each of these categories, with a greater number of concurrent sales and shipments when other wheat varieties are included. Shipments on average are relatively constant across all quarters in both wheat equations. First- and second-quarter sales are important to HRW shipments, whereas sales are spread more evenly across all quarters in the all-wheat block.

Conclusions

Table 4 gives a clearer understanding of the temporal relationships between export sales and export shipments of corn, soybeans, wheat, and HRW wheat than does the simple lagged-variables equation structure of tables 2 and 3. A better understanding of lead/lag structures is important to export merchants and shippers, to transportation economists, and to

those individuals (in both the public and private sectors) who need to predict season-ending export shipment levels at any point in the marketing year. Moreover, the information is important to anyone concerned with commodity prices or grain and soybean marketing, both domestic and foreign because deviations from quarter-specific trends could affect prices.

A natural extension of this work is a comparison of estimating equations for export shipments. It is entirely plausible that shipments, especially in the short run, can be better predicted from a lag relationship on sales than from an econometric specification of shipments on economic variables. Reversing the estimating equations in the text, thereby expressing sales as a function of current and future shipments rather than shipments as a function of lagged sales, is also possible. The empirical question becomes: "When will the commodity be shipped?" rather than: "When was the commodity sold?"

The major contribution of this study is to show that export sales and export shipments of agricultural commodities differ dramatically, especially in the short run. Furthermore, simple econometric specifications do not explain enough of the variation between the two variables to allow one to predict shipment levels based on past sales. Researchers estimating economic parameters of the agricultural export sector cannot interchange these variables and obtain meaningful results. Past research has used export shipments as the export variable in modeling international agricultural trade, when the use of export sales would have been more correct. Thompson maintains that one of the two major problems with empirical work in international agricultural trade is specification error that biases estimates of the elasticity of export demand (*15*, p. 10). This elasticity was of crucial importance in discussions leading to the Food Security Act of 1985, with estimates ranging from highly inelastic to highly elastic. Knowledge of institutional structures in the export sector would help researchers better formulate the econometric models that generate the parameters used not only by policymakers but also by industry and private analysts who forecast prices and export quantities.

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In Earlier Issues

The application of a formal model to policy research is often accompanied by skepticism on the part of some and by the belief on the part of others that what comes out of a computer is automatically right. Both reactions are incomplete. No formal model has yet predicted aggregate response with consistent accuracy. Neither has any informal model. But all too often, formal models are reported in the literature as though their purpose is to replace informal methods. A really effective tool kit must include both types.

W. Neill Schaller
Vol. 20, No. 2, April 1968

Economic Impacts on Consumers, Growers, and Processors Resulting from Mechanical Tomato Harvesting in California—Revisited

By C.S. Kim, Glenn Schaible, Joel Hamilton, and Kristen Barney

Abstract. This article measures economic gains to consumers and processors of adopting mechanical tomato harvesters in California, recognizing the oligopsonistic behavior of processors in the raw tomato market. It provides a theoretical basis for using a kinked longrun supply curve to measure producer surpluses when the estimated supply curve intersects the horizontal axis. Consumer benefits are inflated approximately 25 percent when one misspecifies the raw tomato market as perfectly competitive. Producer benefits from adopting mechanical harvesting are positive and exceed estimates in previous studies.

***Keywords.** Economic surplus, technological change, imperfect competition, processors, tomatoes*

Mechanization has dramatically affected the harvesting method of processing tomatoes in California. Between 1961 and 1969, the mechanical harvest of processing tomatoes jumped from a mere 4 percent to nearly 100 percent. As a result, tomato acreage more than doubled from 130,000 acres in 1960 to 270,000 acres in 1977.

Economic adjustments resulting from the adoption of mechanical tomato harvesters in California have been complex and far reaching. A change of this magnitude and speed led researchers to estimate the change in benefits to both consumers and producers (*3*), the reduced harvesting costs of the mechanical tomato harvester, and the cost of displaced farmworkers (*15*).[1] These studies, however, failed to consider how imperfect competition in the raw product market affects the size and distribution of the welfare impacts. Tomato processors in California buy tomatoes from growers under contractual arrangements in an oligopsonistic market (*2, 5, 6, 10*). Chern and Just claim:

> There are few processors in the industry. It is, therefore, plausible to consider that the processors may procure raw tomato supply in a so-called oligopsonistic market.... Informal interviews with growers (in this study) confirmed an earlier observation by Collins, Mueller, and Birch that most processors follow leadership pricing as a policy (*5*).

Thus, by failing to recognize the imperfect nature of the raw product market, past research has assigned too many welfare benefits to consumer surpluses rather than to processor profits.

Furthermore, previous studies of the tomato market were based on the supply curve intersecting the horizontal axis. This specification has generated controversy over the estimation of producer benefits. The controversy arises from the failure of economists to reconcile economic theory and econometric results. We need to discuss these theoretical problems and make alternative specifications of the supply curve that reflect fundamental economic theory more closely.

We have two objectives here.[2] First, recognizing the imperfectly competitive behavior in the processing sector, we estimate the economic gains to consumers and processors of adopting mechanical tomato harvesters in California. We then compare the results with estimates made under misspecification that the raw tomato market is competitive.

Second, we estimate producer benefits from adopting mechanical tomato harvesters in California by apply-

Kim and Schaible are agricultural economists, and Barney is a junior economist with the Resources and Technology Division, ERS; Hamilton is a professor at the University of Idaho. The authors thank Kuo S. Huang and two anonymous reviewers for their helpful suggestions in revising the initial draft of this manuscript.

[1]Italicized numbers in parentheses refer to items in the References at the end of this article.

[2]This study did not estimate the cost associated with displaced farmworkers. Other research has addressed this issue (*15*). The revised estimates of processor benefits provided for here are unaffected by any cost estimates of displaced farmworkers. Such costs would alter net social benefits only. By excluding the issue of displaced farmworkers, we do not diminish its importance, but we focus attention on the appropriate theoretical and empirical estimation of benefits to consumers, producers, and processors.

ing an alternative specification of the longrun supply curve from that specified in previous tomato market studies. Specifying a vertical shift in the supply curve, we estimate producer benefits and compare them with those estimated by Brandt and French (*3*).

Economic Gains to Consumers and Processors

We estimate the change in consumer benefits due to the adoption of mechanical tomato harvesters by summing the relevant areas under the consumer demand functions for tomato products. However, consumer demand for all processed products is not available, and the processed product demand functions do not account for all the tomatoes processed (*3*). Therefore, an alternative approach is needed to estimate consumer benefits.

In a path-breaking article, Just and Hueth explicitly show, by using the envelope theorem, that the area behind a general equilibrium demand curve in the input market measures quasi-rents to producers plus final consumer surpluses; therefore, consumer surpluses from the input markets equal consumer surpluses of output markets in the long run (*11*). Assuming longrun competitive equilibrium, Anderson (*1*) and Carlton (*4*) also show that consumer surpluses can be measured in either the input or the output market. Therefore, the input demand curve can be used to measure consumer surpluses under a competitive market structure.

Just and Chern used the perceived demand curve to represent the derived demand under an oligopsonistic market structure (*10*). Assuming competitive behavior on the supply side, Just and Chern (*10*) and French (*7*) show that, with parallel shifts in the linear supply curve, market observations of prices and quantities trace out a perceived demand curve. The perceived demand intersects the vertical axis at the same point as does the derived demand curve that would apply under perfect competition, but the perceived demand curve lies below the derived demand curve. The degree to which the perceived demand curve deviates from the derived demand curve depends on the structure and behavior of the oligopsony that exists in a particular market.

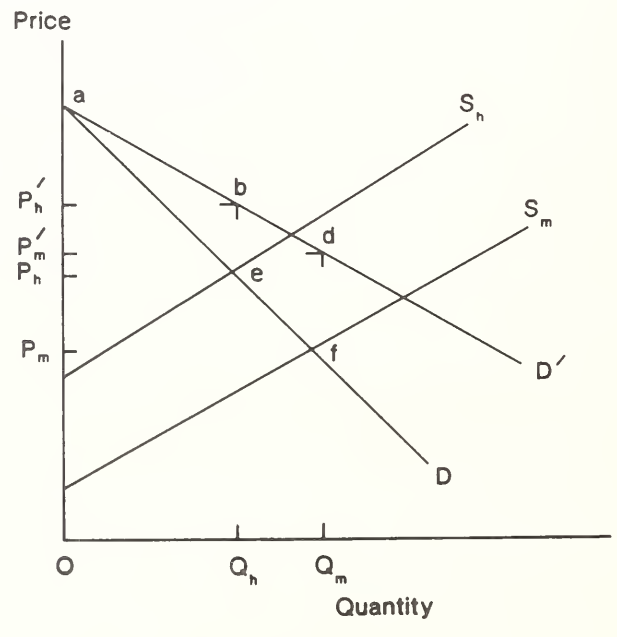
Because the input demand curve under imperfect competition lies below the derived demand curve under perfect competition, the area below the perceived demand curve, but above the equilibrium contract price, does not properly measure consumer surpluses in an oligopsonistic market. Tomato processors in California purchase tomatoes from growers in an oligopsonistic market. Therefore, measuring welfare impacts based on a perceived demand curve improperly allocates a greater share of welfare impacts to consumer surpluses, by incorporating a portion of processor profits.

Figure 1 illustrates how consumer surpluses are measured: (1) under the assumption of an oligopsonistic market using a perceived demand curve, and (2) under the assumption of perfect competition, but given the same input quantities supplied to the processing sector. Curve D represents the perceived demand curve that is relevant under actual conditions of imperfect competition, whereas curve D′ represents the value of the marginal product (derived demand) curve under conditions of perfect competition. Curves S_h and S_m are supply curves, assuming hand and mechanical harvest, respectively.

Given quantities Q_h and Q_m and assuming hand and mechanical harvest technologies, respectively, under conditions of imperfect competition, grower prices are P_h and P_m, respectively. Given the same quantities, Q_h and Q_m, under conditions of perfect competition, processors would pay growers P'_h and P'_m, respectively. Under perfect competition, consumer surpluses are measured under the D′ curve as abP'_h and adP'_m, respectively. However, previous studies measured consumer surpluses before and after tomato harvesting by areas under the perceived demand curve, aeP_h and afP_m, respectively.

Figure 1

Changes in consumer and producer surpluses and processor profits resulting from mechanical tomato harvesting



The differences in these respective areas (for hand and mechanical harvest market situations separately) measure the gains that processors are able to capture because of the oligopsonistic nature of the industry. Area $P_h ebP'_h$ represents the gains in precessor profits prior to mechanical harvesting, whereas area $P_m fdP'_m$ measures the gain to processors after mechanical harvesting. Because the oligopsonistic market structure will prevail, processor benefits will not be driven to zero in the long run.

Consumer benefits (CB) resulting from adoption of mechanical tomato harvesters in California are represented by the trapezoid $P'_h bdP'_m$ in figure 1; therefore, CB are measured as follows:[3]

$$CB = 0.5(P'_h - P'_m)(Q_h + Q_m) \tag{1}$$

However, this equation still has two unobservables, P'_m and P'_h.

Under imperfect competition, P'_m and P'_h can be approximated by the following:[4]

$$P'_h = P_h(1 + F_h) \quad \text{or} \quad P_h = P'_h/(1 + F_h), \tag{2}$$

and:

$$P'_m = P_m(1 + F_m) \quad \text{or} \quad P_m = P'_m/(1 + F_m) \tag{3}$$

where F_h and F_m are price flexibilities of supply for hand and mechanical harvest, respectively.

Therefore, consumer benefits in equation 1 can then be written as:

$$\begin{aligned} CB = 0.5[&(P_h - P_m)(Q_h + Q_m) \\ &- (P_m F_m Q_m - P_h F_h Q_h) \\ &+ (P_h F_h Q_m - P_m F_m Q_h)] \end{aligned} \tag{4}$$

Note that the last term $(P_h F_h Q_m - P_m F_m Q_h)$ in equation 4 becomes zero for the linear perceived demand curve.[5]

Processor gains (PG) may be represented by the difference between processor profits after mechanical harvesting $(P_m fdP'_m)$ and processor profits prior to mechanical harvesting $(P_h ebP'_h)$. This difference can be measured as:

$$PG = (P'_m - P_m)Q_m - (P'_h - P_h)Q_h$$

If one substitutes P'_h and P'_m from equations 2 and 3, respectively, and simplifies, processor gains are:

$$PG = P_m F_m Q_m - P_h F_h Q_h \tag{5}$$

The estimates of F_h, F_m, P_h, P_m, Q_h, and Q_m needed to estimate consumer benefits and processor gains, by use of equations 4 and 5, are available from Brandt and French who conducted simulation analyses based on a system of econometric models of the processing tomato industry in California (*2*). They estimated changes in acreage allocated to tomato production for processing and grower prices without mechanical tomato harvesting under four different scenarios with respect to labor costs. If we use the estimates of P_h and Q_h from Brandt and French, the computation of consumer benefits and processor profits reveal that consumer benefits are inflated by approximately 25 percent when one misspecifies the raw product market as competitive under the four scenarios (table 1). Overestimated consumer benefits range from nearly $70 million to $200 million, depending on different scenarios associated with labor costs.

It is interesting to observe how much the perceived demand curve under imperfect competition deviates from the raw product demand curve that would prevail under perfect competition. Because producer prices under imperfect competition are discounted by the price flexibility of supply as shown in equations 2 and 3, the producer price is less than it would be

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[3]Equation 1 would overestimate or underestimate consumer surplus in cases where the segment bd of the value of marginal product curve (D') is convex or concave, respectively. Because the value of the marginal product curve is more elastic than the perceived demand curve, the change in price for a given change in quantity is small. Therefore, the trapezoid area $P'_h bdP'_m$ can be regarded as the limit of actual consumer surplus for a decrease in price.

[4]Under imperfect competition, processors attempt to operate at a level of raw product utilization Q_i that maximizes their profits:

$$\pi = P_y{*}Y - P_i{*}Q_i \qquad i = h \text{ (hand) or } m \text{ (mechanical)}$$

given a processor production function $Y = f(Q_i)$ and the price of processed output P_y. The maximum is given by (see (*5*) for a complete analysis):

$$\frac{\partial \pi}{\partial Q_i} = P_y \frac{\partial Y}{\partial Q_i} - P_i - Q_i \frac{\partial P_i}{\partial Q_i} = 0$$

$$P_y \frac{\partial Y}{\partial Q_i} = P_i\left(1 + \frac{\partial P_i}{\partial Q_i}\frac{Q_i}{P_i}\right) = P_i(1 + F_i)$$

where $F_i = \dfrac{\partial P_i}{\partial Q_i}\dfrac{Q_i}{P_i}$

Since $P_{ci} = Py \dfrac{\partial Y}{\partial Q_i}$ under perfect competition, it follows that:

$$P_{ci} = P_i(1 + F_i).$$

[5]
$$\begin{aligned} P_h F_h Q_m - P_m F_m Q_h &= P_h Q_m \frac{Q_h}{P_h}\frac{dP_h}{dQ_h} - P_m Q_h \frac{Q_m}{P_m}\frac{dP_m}{dQ_m} \\ &= Q_h Q_m \left(\frac{dP_h}{dQ_h} - \frac{dP_m}{dQ_m}\right) \\ &= 0 \text{ since } \frac{dP_h}{dQ_h} = \frac{dP_m}{dQ_m} \text{ for the linear demand curve.} \end{aligned}$$

Table 1—Consumers' benefits from adopting mechanical tomato harvesters in California, 1960-77

Scenario[1]	1	2	3	4
	1,000 dollars			
Consumer benefits	296,857	444,332	578,930	732,979
Amount attributed to processor profits	69,721	108,439	146,228	196,778
Consumer benefits under the mis-specification that the factor market is competitive[2]	366,578	552,771	725,158	929,757

[1]Scenario 1 assumes labor fully available at wage rates experienced with mechanical harvest development. Scenario 2 increases effective wage costs by 30 percent over scenario 1. Scenario 3 increases effective wage costs by 60 percent over scenario 1. Scenario 4 increases effective wage costs by 100 percent over scenario 1.

[2]Brandt and French's estimates of consumer benefits (*3*, p. 271).

under perfect competition. According to Brandt and French, the elasticity of raw tomato supply is 1.627 and real grower price was \$32.06 per ton in 1977 (*2*). The deviation between the perceived demand curve and the raw product demand curve under perfect competition in 1977 (that is, $P'_m - P_m$ in figure 1) can be measured as:

$$\begin{aligned} P'_m - P_m &= P_m(1 + F_m) - P_m \\ &= P_m \times F_m \\ &= \$19.70 \end{aligned} \tag{6}$$

Therefore, had a perfectly competitive market existed in the factor market, growers would have received \$51.76 per ton of tomatoes. The difference of \$19.70 per ton represents processor gains and the degree to which the perceived demand curve deviates from a raw product demand (D') curve under perfect competition.

Producer Benefits

Mechanical harvesters are generally assumed to reduce harvesting costs by substituting capital for labor, but not to change yield per acre (*9*). Thus, in our analysis, any increase in supply results from an expansion in acreage, which in turn is explainable by a technology variable (the adoption rate of mechanical tomato harvesting), explanatory price variables, and the reduction of uncertainty associated with harvest by handpickers. Thus, with the introduction of mechanical tomato harvesting in California, producers who realize lower harvesting costs will expand acreage devoted to producing tomatoes for the raw product market (for example, $Q_m - Q_h$ in fig. 2).

Producer surpluses before and after adoption of the mechanical tomato harvester are represented by the areas P_hE_hA and P_mE_mB, respectively, in figure 2. Therefore, producer benefits, represented by the change in producer surpluses, are measured by the area $P_mE_mTP_t$. These producer benefits (PB) can be estimated as:[6]

$$PB = 0.5(P_m - P_t)(Q_m + Q_h) \tag{7}$$

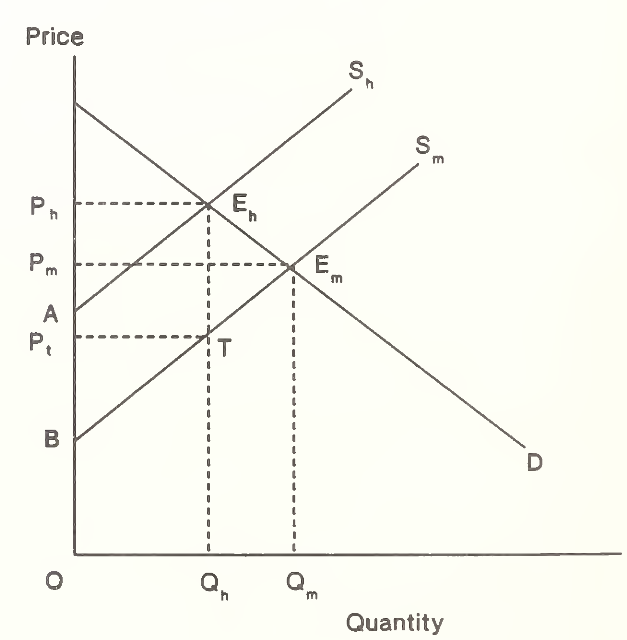
where the value P_t represents that price at which the area of producer surpluses P_tTB equals P_hE_hA (the area of producer surpluses prior to mechanical harvesting) in figure 2. The remainder of the producer surpluses after mechanical harvesting represents producer benefits. To apply the formula in equation 7, we needed information on P_t. We, therefore, applied the acreage response function estimated by Brandt and French (*2*, p. 52):

$$\begin{aligned} A_t = \underset{(20.30)}{56.70} + \underset{(0.0681)}{0.2551}\left[YMAC_t(GP_t)\right] - \underset{(0.0681)}{0.2551}\, GC_{t-1} \\ + \underset{(0.1767)}{0.1982}\, TC_t + \underset{(0.1445)}{0.5978}\, A_{t-1} \end{aligned} \tag{8}$$

[6]Producer benefits measured with equation 7 implicitly assume that the supply shift is parallel. Therefore, results would either overestimate or underestimate producer surpluses, depending on whether the supply shift is pivotal or convergent. However, Rose pointed out that the only realistic strategy is to assume that the supply shift is parallel (*14*).

Figure 2

Changes in consumer and producer surpluses resulting from technological change



where YMAC measures the 3-year lagged moving-average of California yield (tons/acre), GP represents raw tomato contract price ($/ton), GC measures representative average growers' cost of producing tomatoes in California ($/acre), and TC measures the adoption rate of mechanical tomato harvesters in California. The numbers in parentheses below coefficients are estimated standard errors.

The longrun acreage response function obtained by solving the first-order difference equation 8 is represented in the following form:

$$A_t = a_t + 0.6343(YMAC_t)(GP_t) \qquad (9)$$

where a_t is an intercept term. One can obtain a supply equation by multiplying the longrun acreage response equation 9 by yield per acre, YLD, as follows:

$$Q_t(s) = a_t^* + [0.6343(YMAC_t)(YLD_t)]GP_t \qquad (10)$$

where $a_t^* = a_t(YLD_t)$ and $Q_t(s) = (YLD_t)(A_t)$. Partial differentiation of equation 10 with respect to GP is given by $dQ_t/dGPt = 0.6343\ [(YMAC_t)(YLD_t)]$. When one then solves for $d(GP_t)$, the distance between P_m and P_t in figure 2 is measured by $dQ_t/\ [0.6343(YMAC_t)(YLD_t)]$ where $dQ_t = Q_m - Q_h$. By substituting $(P_m - P_t)$ for $d(GP_t)$, one can estimate the unknown variable P_t by:

$$P_t = P_m - (Q_m - Q_h) / [0.6343(YMAC_t)(YLD_t)] \qquad (11)$$

If one inserts equation 11 into equation 7, producer benefits resulting from mechanical tomato harvesters in California range from $70 million to nearly $200 million, depending on the scenario specified with respect to labor costs (table 2).

Supply Specification and Producer Surpluses

Brandt and French obtained empirical linear supply curves that intersected the horizontal axis for several scenarios they considered (*2*). Their results included several instances of negative producer benefits (table 2). If the longrun supply curve intersects the horizontal axis, this situation violates Euler's theorem, the fundamental economic theorem that total output would be exhausted in the long run.

Several authors have attempted to explain the phenomenon of a longrun supply curve intersecting the horizontal axis. Lindner and Jarrett showed that a statistically estimated supply curve may not provide reliable information on the intercept term because the intercept usually falls well outside the range of the data used to estimate the curve (*12*). Pindyck and Rubinfeld also demonstrated that the interpretation of the intercept depends on whether sufficient observations near the point where all explanatory variables are zero are available to yield statistically meaningful results (*13*). In cases where enough observations are unavailable, one can draw no valid conclusions.

Table 2—Producers' benefits from adopting mechanical tomato harvesters in California, 1960-77

Scenario[1]	1	2	3	4
	1,000 dollars			
Producer benefits	70,058	108,586	146,338	197,036
Producer benefits with the supply curve assumed to intersect the horizontal axis[2]	-61,952	-9,945	77,551	164,010

[1]Scenario 1 assumes labor fully available at wage rates experienced with mechanical harvest development. Scenario 2 increases effective wage costs by 30 percent over scenario 1. Scenario 3 increases effective wage costs by 60 percent over scenario 1. Scenario 4 increases effective wage costs by 100 percent over scenario 1.

[2]Brandt and French's estimates of producer benefits (*3*, p. 271).

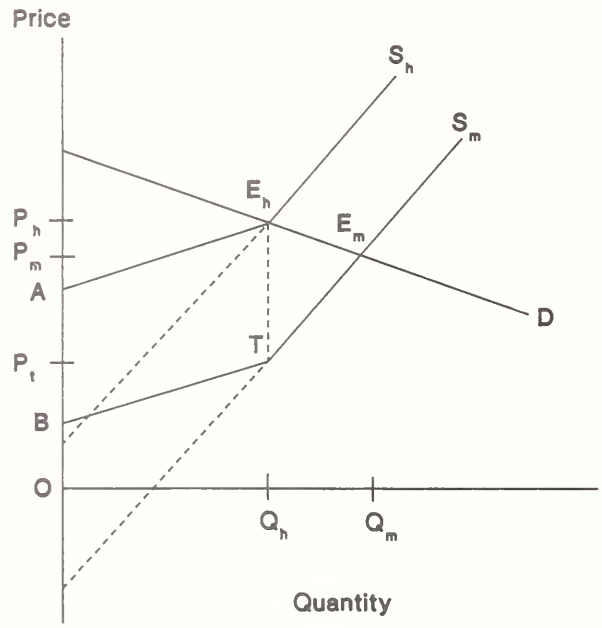
To deal with this problem conceptually, a few authors have assumed that the longrun supply curve asymptotically approaches the horizontal axis in cases where the statistically estimated supply curve intersects the horizontal axis. Figure 3 illustrates a case that uses a kinked supply curve as assumed by Groenewegen and Cochrane (*8*), Lindner and Jarrett (*12*), Rose (*14*), and Wise and Fell (*16*). Groenewegen and Cochrane for example, assumed that the U.S. grain supply curve intersects the vertical axis at the loan rate (*8*).

Estimates of producer benefits are clearly subject to the assumptions one makes about the shapes of the supply curves and how they shift. If one assumes a horizontal shift of the supply curve, then the estimated producer benefits would approach those estimated by Brandt and French (*3*). Although the implication of Lindner and Jarrett's work (*12*) is that the true shape and shift will not be revealed by econometric means, we suspect that Brandt and French's estimates (*3*) of producer benefits are biased downward.

We estimated producer benefits under the assumptions that the supply curves were kinked, and that the introduction of mechanical tomato harvesters results in a vertical supply curve shift (fig. 3). Based on these assumptions, producer benefits (table 2) from adopting mechanical harvesters are positive and are sub-

Figure 3

Welfare changes with the kinked supply curve



stantially larger than the estimates of Brandt and French (*3*).

Conclusions

We have estimated economic gains to growers (producers), processors, and consumers from adopting mechanical tomato harvesters in California, using a model that recognizes that processors purchase raw tomatoes from growers under contractual arrangements within an oligopsonistic market. Both consumers and producers are better off from the use of mechanical tomato harvesters. Consumer benefits range from a low of \$296.9 million to a high of \$733.0 million, and producer benefits range from a low of \$70.1 million to a high of \$197.0 million, depending on which set of labor costs one assumes. Consumers receive more benefits than producers by approximately 4:1 under the different scenarios.

We have shown that earlier estimates of consumer benefits, under the misspecification of the factor market, are overstated by approximately 25 percent because they include amounts that should be attributed to processor profits. Processor gains range from a low of \$69.7 million to a high of \$196.8 million under the different scenarios. Producer benefits were probably underestimated by Brandt and French because of a misinterpretation of empirical linear supply curves that intersected the horizontal axis.

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In Earlier Issues

Changing technology and farm size have significantly altered the agricultural economy, including the agribusiness industries which supply production inputs to agricultural producers. A problem faced by all segments of the agricultural economy is one of anticipating the effects of technological innovation.

Gordon E. Rodewald, Jr. and Raymond J. Folwell
Vol. 29, No. 3, July 1977

Book Reviews

Agricultural Policy and Trade: Adjusting Domestic Programs in an International Framework: A Task Force Report to the Trilateral Commission

Reviewed by Nicole S. Ballenger

D. Gale Johnson, Kenzo Hemmi, and Pierre Lardinois, New York: New York University Press, 1985, 132 pp., $25.00.

In September 1986, ministers to the General Agreement on Tariffs and Trade (GATT) met in Punta del Este, Uruguay, where they successfully bridged their disagreements and forged a broad agenda for the eighth round of multilateral trade negotiations (MTN) held since the GATT was established. Hard bargaining is expected to be under way this spring, and agriculture will receive notably greater attention in this round than ever before. Agricultural subsidies are a particularly contentious issue. Reaching an agreement on the language on subsidies contained in the agenda was one of the major stumbling blocks to launching the new round. At the top of U.S. Trade Representative Clayton Yeutter's list of U.S. priorities for the trade talks was "an end to export subsidies in farm trade" (*The Washington Post,* Sept. 9, 1986). The contracting parties to the GATT have agreed to a broader goal: to increase discipline on the use of all direct and indirect subsidies and other measures directly or indirectly affecting agricultural trade. The big question raised by many observers is by how much the United States will agree to adjust its own extensive farm price and income support programs to induce the Europeans to rein in their controversial Common Agricultural Policy, whose 1986 farm export subsidies exceeded $8 billion.

For economists and noneconomists alike who will be following (possibly for several years) the upcoming talks on agriculture, *Agricultural Policy and Trade* is excellent background reading. The intent of the book, which was prepared under the auspices of the Trilateral Commission, is to recommend "internationally constructive" changes in the agricultural policies in each of the Trilateral partners (the United States, the European Community, Canada, and Japan). Internationally constructive changes, according to the authors, are those that would reduce the distortions that permeate agricultural production and trade and that limit the adverse international trade effects of domestic farm programs. The authors argue that, given the Trilateral countries' awareness of the costliness of their policies in terms of prices to consumers, budget deficits, and the health of the international trading system, the stage is now set for progress in this direction and that "the new GATT Round provides an opportunity which should not be lost" (p. 56). They also suggest that GATT rules regarding agriculture be changed to provide effective multilateral discipline over the agricultural trade and domestic policies of GATT-member countries.

This book is remarkably short and is clearly and concisely written. In 56 pages of text the authors give an overview of four main topics: (1) the current domestic farm programs of the Trilateral partners, (2) the implications of these policies for international trade and the inadequacies of the GATT in dealing with their impacts, (3) the adjustments involved in making the transition to more market-oriented policies, and (4) the authors' priority recommendations for each country and for GATT revisions. The coverage of the first two topics is particularly good. The authors unravel and present in lay terms the essential features and workings of the Trilateral countries' highly complex farm programs. The descriptions of the farm policies and their economic impacts will be useful to both agricultural and general economists, but will not alienate noneconomists.

The welcome simplicity with which agricultural policy issues are discussed, however, signals one of the book's weaknesses: the authors make trade liberalization sound awfully easy even though they know otherwise. The crux of their recommendations is that domestic farm price relationships should more closely reflect international price relationships and that domestic farm programs should not be allowed to distort or destabilize international markets. For ex-

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ample, in the case of the United States, they suggest that U.S. "deficiency payments for grains and cotton need to be gradually eliminated" and that "dairy price supports should be reduced to a level that would eliminate domestic production in excess of domestic consumption and then be further reduced to determine if U.S. dairy producers could compete with unsubsidized dairy exports from other producing areas" (p. 47). The authors compiled data and analyses (which are offered in an appendix in support of their recommendations) from existing studies of agricultural policy and trade liberalization. These studies generally indicate that, in the absence of protectionism, world agricultural prices would have been higher and less volatile. They also indicate that costs to many countries' consumers, as well as to taxpayers, would have been lower. However, they do not show clear gains for U.S. farmers. For example, studies indicate that U.S. dairy, sugar, wheat, peanut, and rice farming could be less profitable. The results the authors present do not clearly indicate that liberalization would help the United States recapture its recently lost world market shares. In short, the book's recommendations would be much easier for the reader to accept if the authors provided a convincing economic rationale that individual, politically powerful commodity groups could also accept.

The lengthy appendix supporting the text is a useful reference source and handbook for anyone researching agricultural trade and policy issues related to the United States, Canada, the European Community, or Japan. It adds detail to the discussion of the agricultural policies of these countries, provides numerous tables of supporting data, and reviews the results of previous studies of agricultural trade liberalization. Data reported in the appendix include government expenditures on agricultural programs, selected estimates of nominal and effective rates and protection, estimates of costs of farm programs to taxpayers and consumers, estimates of the effects of protection on the agricultural trade balance, and other general agricultural statistics for the countries covered by the report. It is unfortunate that, because the data are drawn from so many unrelated sources, little of the policy information can be compared directly across countries. This flaw is an indication, duly noted by the authors, that considerable work still needs to be done in support of an MTN for agriculture.

Getting Prices Right: The Scope and Limits of Agricultural Price Policy

Reviewed by David Henneberry

C. Peter Timmer. Ithaca: Cornell University Press, 1987, 160 pp., $25.00 ($7.95 paper).

Getting Prices Right by C. Peter Timmer is a welcome addition to the vast literature on agricultural price policy in developed and developing areas that has emerged over the past 20 years. The book blends common sense and economic theory in an uncomplicated manner that professionals with overseas experience will appreciate for its applicability in data-scarce environments. It is a short book (160 pages) that introduces the reader to basic concepts in the area of agricultural price policy.

Timmer describes the components of price policy analysis. He sets forth the partial-equilibrium framework for price policy analysis. He analyzes food and agricultural price subsidies: the direct effects of a subsidy, spillover effects, the impact on the volume of trade, foreign exchange, market integration, resource allocation, and the cost of funding the subsidy. He underplays the role of taxation and export tariffs in agricultural price formation. The sheer size of the agricultural economy in many developing countries implies that agriculture is a source of significant government revenues, a topic that would have broadened the scope of the manuscript. Timmer discusses the impact of agricultural price policy on markets and marketing. He relates storage, transportation, and processing of agricultural commodities to Government price policy. He explains the concept of the border price as an efficiency standard, or as the opportunity cost of a commodity on world price, such as location and delivery terms and time, emphasizing their role in the policy formulation process. His explanation of the disaggregated effects of agricultural price policy on consumers and producers is incomplete. He gives scant attention to the impact of these effects on Government revenues, making no real effort to capture the differences among policies (subsidies vs. tariffs) and countries (large vs. small). Timmer links price from single markets to general equilibrium. He briefly discusses the macroeconomic impact of agricultural price changes on Government budget, deficits, inflation, labor markets, investment, and the structure of the economy. Finally, he summarizes markets, policies, and the dynamics of price changes.

Getting Prices Right is oriented to an informed lay audience and junior- or senior-level undergraduate students in land-grant universities. One needs only a basic understanding of graphical analysis to comprehend the material. The book is devoid of quantitative theoretical and methodological discussion. Timmer does use practical examples from the actual experiences of several countries to highlight his main points. These examples enhance his book's readability.

Getting Prices Right has several strong points. It is pragmatic and oriented toward an informed lay audience. It is authoritative and based on years of overseas work experience from which numerous examples are drawn. It focuses on a specific topic. Last, it is well written and easy to understand.

The book's major weakness is its scope. It fails to address adequately the price problems dealt with by the agricultural economics literature over the past two decades. The topics it covers offer only a superficial glimpse into the underlying economic effects. For example, demand elasticities and related coefficients, commodity price stabilization schemes (benefits, costs, alternatives, and determinants of the distributional impact), and the impact of risk-aversion on supply and demand response are either inadequately addressed or ignored. The crucial difference between the case of a large country's ability to influence world market prices through government policy intervention and a small country's inability to do so is nearly overlooked. The reader is essentially uninformed of these critical differences.

The title of the book, *Getting Prices Right,* indicates another shortfall. Although the book focuses on agricultural price policy in developing areas, the solution to many problems must involve far more than simply "getting prices right." Institutional factors such as the structure of markets, the distribution of personal income, and the land tenure system are too

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large to be completely ignored. The author does not imply that these factors are unimportant or that they should not be considered; he simply excludes them from his analysis.

In all fairness, one cannot fault a book for not being what its author did not intend. Timmer is a skilled economist who eloquently portrays the accumulation of his experience through practical and theoretical examples. *Getting Prices Right* would be ideal for a 2-week short course given to policymakers in developing areas. It would not, however, be sufficient as the sole text for an undergraduate or graduate course. Graduate students and working professionals interested in the area should probably read the book for its hand-me-down logic, but they may be frustrated when important topics are raised and analyzed in so elementary a fashion.

Watershed Resources Management: An Integrated Framework with Studies from Asia and the Pacific

Reviewed by George A. Pavelis

K. William Easter, John A. Dixon, and Maynard M. Hufschmidt (eds). Boulder, CO, and London: Westview Press, 1986, 236 pp., $24.00.

The book is the product of several workshops held from 1983 to 1985 at the East-West Center in Hawaii on how technical knowledge can be used to guide the monitoring of soil and water conservation problems and to generate alternative conservation policies. Translating soil and water conservation principles into effective policies was regarded as a major hindrance to solving serious erosion and related problems in the Pacific region, particularly on uplands traditionally used for forestry and considered the most vulnerable to conversion to crop production. A multidisciplinary approach to conceptualizing conservation problems and to developing alternative solutions within defined hydrologic problem areas, or watersheds, is the central theme of this book.

As setting for a series of watershed case studies for Hawaii, Indonesia, the Philippines, Thailand, and other Asian regions, the first nine chapters discuss essential elements of an integrated framework for analyzing watershed problems and for developing the best management programs. Economic factors and analytical techniques are prominent, but not preeminent, elements of this framework. Political considerations, institutions, organizational arrangements, and educational activities are considered as important as economic factors are in successfully implementing such programs. Determining optimum resource use, as such, is management in a narrow sense. In a systems sense, it also involves institutional, organizational, and other implementing arrangements, all influenced by underlying biophysical relationships assessed within the same sets of processes.[1]

I regard *Watershed Resources Management* as a useful companion volume to important earlier works,[2] particularly *The Economics of Watershed Planning* (EWP). It is a pity EWP is given only passing mention in this new book, and only by Dixon and Easter in their chapter on economic analysis at a watershed level (p. 61). The volume edited by Tolley and Riggs also involved authors from various disciplines, who recognized the importance of physical data and interdisciplinary teamwork, as well as institutions, and who used watersheds as unified study, planning, and project areas.

Watershed Resources Management does, however, have several major strengths that warrant the serious attention of natural resource and other agricultural economists. Early on, the point is made that, given the tendency of interest groups to recognize in straight economic studies only those conclusions favoring their position, studies using economics allied with hydrology, sociology, and other disciplines are more easily defended and more readily accepted. The book stresses the useful byproducts of cooperative research and planning, the explicit treatment of externality relationships, discount rate choices and other macroeconomic considerations, and some special management relationships in Pacific areas that are not encountered in the mainland United States.

Chief among the advantages of viewing watershed management as a process linking planning and implementation are the lessons learned from monitoring performance as soon as implementation begins. Collecting lacking data as part of planning rather than as a preliminary or recommended followup activity is a major improvement. It eliminates the need for *ex post facto* evaluations, in which projected and actual results are compared, but

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The reviewer is an economist with the Resources and Technology Division, ERS.

[1]C.E. Kindswater (ed.), *Organization and Methodolgy for River Basin Planning: Proceedings of a Seminar on the U.S. Study Commission, Southeast River Basins* (Atlanta: Georgia Institute of Technology, 1964).

[2]John Muelbeier, *Organizing for Watershed Development,* South Dakota Agr. Expt. Station Circular 133 (1957), and G.S. Tolley and R.E. Riggs (eds.), *Economics of Watershed Planning,* Proceedings of a symposium sponsored by the Southeast Land Tenure Committee, the Farm Foundation, and the Tennessee Valley Authority (Ames: Iowa State Univ. Press, 1961).

usually with regard to data available when planning began.

Regarding externalities (decisions of individuals that affect the welfare of others), Dixon and Easter consider the case where upstream and downstream areas managed by different decisionmakers, although externalities within single decision units are just as possible. Externalities occur "because improper upland cultivation practices can result in increased erosion and sedimentation on downstream fields or areas" (p. 53). These externalities or costs are negative. Dixon and Easter also describe the opposite situation, where an active reforestation program in uplands decreases erosion, thereby increasing downstream benefits. They explain that externalities are internalized in the watershed approach, in that economic analysis must include "a search for ways in which externalities can be first identified and then explicitly incorporated into decisions." The book stresses this point throughout; it is a shorthand restatement of Timmons' concepts of "source-consequence areas," "disassociations" of costs and benefits (externalities), and completed associations of costs and benefits (internalized externalities).[3] Such ideas have a common origin in what Pigou simply called marginal social costs.

I see the resolution of externalities as a two-stage process. The consequences of an action (or inaction) by a group or area may be identified, measured, and associated (stage 1.) Two recent U.S. Department of Agriculture reports can be considered stage 1 determinations at an aggregate U.S. level.[4]

To be fully internalized, the externalities must result in revised management decisions (stage 2). But this process may require some fundamental policy decisions as to whether upstream (onsite) interests are to be held directly accountable for downstream (offsite) damage, either by onsite reduction, compensation to offsite parties, or payment for the required downstream protective measures.

The book only touches on the relevance of welfare economics to resource management and does not explain how stage 2 might be implemented within a watershed framework. In welfare economics terms, watershed management programs could be viewed as reorganizations of resource use combining stages 1 and 2, in which welfare can be increased by either a more efficient allocation of resources available to participants (onsite or offsite) or an efficient allocation of additional resources made available for management purposes. Welfare in the aggregate can be increased only to the extent that the welfare of any beneficiary or nonbeneficary is not decreased by the execution of such programs.[5] Within this condition, optimal allocations of resources would constitute an optimal watershed management program. The authors suggest some ways such an approach to watershed improvement can be implemented.

Rather than repeat the extensive literature on what discount rate is appropriate in analyzing watershed management alternatives, Dixon and Easter propose that analysts seek guidance from responsible policymakers on the actual discount rate to use or that they replicate benefit-cost or other analyses using a range of rates used recently for public and private investment projects (p. 64). This approach is an improvement over the often confusing information on single-valued discount rates given in some early watershed studies.

In the same vein, Sfeir-Younis points out that similar macroeconomic issues can have important effects on the environment, even indirectly: "Policymakers tend to favor those where immediate changes are possible and visible.... Many developing countries have been faced with severe socioeconomic problems, and these have directed the attention of policymakers away from basic environmental issues." (pp. 77, 79).

Vergara's chapter and the six case studies in the second part of the book indicate that upland areas in developing countries in the Pacific are frequently used for forest production, agroforest production, or other multiple-use combinations. The forested areas may be withdrawn from any other use and provide only protective cover for the watershed (protection forestry). There may be combined forestry and food crop farming (agroforestry) or pasture under trees (silvipastoralism), or the areas may be cleared exclusively for food crop farming. The case studies merit careful study by those who must assess probable effects of increased tree culture under new U.S. farm legislation. For example, the practice in China and elsewhere of foresting wetlands to lower water tables, interspersing them with areas used for crops, may be a feasible

[3]John Timmons, "Economic Framework for Watershed Development," *Journal of Farm Economics,* Vol. 36, No. 6, Dec. 1954, pp. 1170-83.

[4]Marc D. Ribaudo, *Reducing Soil Erosion: Offsite Benefits,* AER-561, U.S. Dept. of Agr., Econ. Res. Serv., Sept. 1986, and Roger Strohbehn (ed.), *An Economic Analysis of USDA Erosion Control Programs,* AER-560, U.S. Dept. of Agr., Econ. Res. Serv., Aug. 1986.

[5]George A. Pavelis, Howard P. Johnson, William D. Shrader, and John F. Timmons, *Methodology of Programming Small Watershed Development,* Iowa Agr. Expt. Station Research Bulletin 493, Apr. 1961.

alternative to either preserving some U.S. wetlands or draining them for agriculture.

Most of the chapters in the book are preoccupied with situations where the divergences between upland and downstream watershed interests involve upland forest versus lowland urbanization and/or intensive agriculture. Many serious conservation problems in the United States and other nations involve watersheds with fairly homogeneous land use patterns, including almost complete cropping.

Because of its thorough treatment of the information and procedural problems encountered in watershed planning, this book should appeal to both physical and social scientists involved in natural resources research, extension, and academic instruction. Although the "conceptual" chapters are incompletely documented and needlessly repetitious, they clearly state that the results of careful economic analysis and engineering can be spoiled by inadequate consideration of the institutional, organizational, and policy environments within which watershed programs must be implemented.

Problems of Methodology

In opening a session on "Problems of Methodology," I have an opportunity to make another plea for sanity in the use of language. Is it really necessary that the semiliterates get away with their misuse of words, and that through sheer repetition the misuse eventually becomes respectable and legitimate by virtue of the authority of a new edition of *Webster's?* I refer, of course, to the misuse of the word "methodology" when actually "method or technique" is meant.

Methodology, in the sense in which literate people use the word, is a branch of philosophy or of logic, though some logicians prefer to regard logic as a part of methodolgy. Semilierates adopt the word when they are concerned neither with philosophy nor with logic, but simply with methods. Instead of "statistical techniques" they would say "statistical methodology," and instead of "research methods" they love to say "research methodology." They do not understand that the same method may be justified on very different methodological grounds, and that from the same methodological position one may defend very different methods of research.

Fritz Machlup
American Economic Review
May 1963

The Writing of Economics

Reviewed by Judith Latham

Donald N. McCloskey. New York: Macmillan Publishing Company, 1987, 63 pp., $6.00 (paper).

McCloskey constantly reminds us, in his newest book, that writing is no optional matter for professional economists. Thinking alone, however brilliant, leaves the job of economics undone. Communicating with others by means of the written word is the best way to reach a large audience. The discipline of writing, furthermore, compels the writer to think more clearly (p. 3).

McCloskey, a professor of economics and history at the University of Iowa, has written several books on economic history and regularly lectures economists around the country on the craft of writing. His latest book, a manual on writing by an economist for other economists, is a gem. The book's sole flaw, if it can be called a flaw, is that it is so witty and beguiling that the casual reader may be tempted to regard it more as entertainment than as instruction.

Those of you who consider yourselves so-so writers can learn the tools of the trade from McCloskey's book, while those of you who are already competent writers can refine them. Those of you who are contributors to *The Journal of Agricultural Economics Research* will want to follow McCloskey's guidelines.

Unclear writing is simply not read—skimmed perhaps, but not read. Therefore, as McCloskey says: "the premise that you can split content from expression is wrong" (p. 4). The giants of modern thought, like Freud, Einstein, and Keynes, who profoundly influenced their contemporaries and succeeding generations, were all splendid writers. The ideas of Samuelson and Galbraith have touched those outside the economics profession because they were so effectively communicated. There's no getting around the fact that clarity of expression and influence are highly correlated.

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What is the economist who would be a better writer to do? And what is that same economist not to do? You will recognize in some of McCloskey's ideas precepts from your college writing courses and from William Strunk and E.B. White's *The Elements of Style* (to which McCloskey in indebted). But, frankly, several of McCloskey's precepts contradict, as they should, the common writing practices of the economics profession. He, for example, recommends using active voice constructions, avoiding jargon, and eliminating lengthy introductions and stage directions for the text. The following highlights from McCloskey's book will help everyone write better.

Things To Do

- Be clear. The reader, not the writer, is "sovereign" p. 7). If any reader thinks something is unclear, it is—by definition. A reader who has too much trouble understanding a passage gives up (p. 8). Dense writing makes slow reading. The writer does not have a captive audience, and readers will ignore, skim, or outright misunderstand messages the writer does not communicate clearly and directly.
- Be brief. Well-known agricultural economist Don Paarlberg used to say: "The relationship between length and reader interest is best represented by a curve that is negative and steep." Therefore, it is wise to comb your writing for extra words, and eliminate them. When using tables, graphs, or equations, ask: "Is this entry necessary?" Get rid of whatever your reader does not need to understand your message.
- Arrange your ideas carefully; be imaginative. Get away from the ho-hum, dreary organization of much economics writing. McCloskey spoofs the arrangement of the typical article: introduction, roadmap (or outline), theory, model, results, suggestions for future research ("since nothing ever works"), and summary (p. 12). A contents paragraph at the beginning is scaffolding and, like all scaffolding, is ugly. Excessive introduction or summarizing is "boilerplate"; it bores the reader (p. 23). Likewise, an article that begins:

"This paper discusses..." is dull (p. 24). Miminize background padding, and avoid elaborate summaries. Consider the needs of the reader who wants to know: What worked, what didn't, how were the questions formulated, and why (p. 24)? The guiding question in all reporting of research should be: So what? You need to answer it.

- Watch your tone. Many writers assume a pompous, scientific pose. They appear to be saying: "this-stuff-is-so-complex-that-I-can't-be-clear," which is an "outright lie" (p. 27). Anything you understand well, you can also explain, if you take the time and make the necessary effort. The writer's purpose should be to help people understand, not to make them "jump through mental hoops" (p. 30). Come down from the ivory tower and use the language of ordinary speech. Choose strong, one-syllable verbs for emphasis. Here's a super example from McCloskey: "The writer who wants to be clear does not *clot* his prose with traffic directions" (p. 25).

- Use the active voice (subject-verb-object sentence order) whenever possible. Active sentences are more forceful than passive ones. Recast passive voice constructions into the active voice to make the implied agent assume responsibility for the action. Limit the use of linking verbs ("is," "are," "was," and "were") because they do not imply action but simply state that a thing exists in a particular form (p. 44).

- Make writing hang together by using repetition to link one sentence to another. The reader can best understand your intent if you develop your ideas logically and link the ideas in each sentence to the previous one by repetition. Repeat key terms, rather than using traffic signals. For example, avoid beginning sentences with adverbs like "also" and "thus"; they are traffic signals (pp. 32-34).

- Get a rough draft as soon as possible. Begin the rough draft as you do your research rather than waiting until the end to write it up. McCloskey refers to writing the first draft as the "teachable trick" (p. 13). It helps get around writer's block and forces the writer to be concerned from the outset with communicating the major steps of the research to the reader in an intelligible way. McCloskey recommends that at the end of each writing session you jot down your thoughts on what will come next, a practice that will help to eliminate mental blocks as you move forward (p. 21). I find this tip, which I'd never heard anywhere before, particularly helpful.

- Read aloud. Reading aloud is the best way to hear your writing as others hear it internally (p. 42). Take pleasure in the language of our best literature, reading it aloud to develop your inner ear. McCloskey lists some of the best writers of economics (such as Heilbroner and Griliches) to use as touchstones for your own writing (see p. 9).

- Revise, revise, revise. Become your own harshest critic and editor. All good writers do. The best writers revised almost endlessly. Hemingway, for example, is reputed to have drafted the last page of *A Farewell to Arms* 60 times. Economists can use McCloskey's guidelines as they revise their own writing.

Remember that writing well is hard work. You have to be committed to communicating your ideas to your readers in the language they will find easiest to understand and most agreeable to accept. You will also have to discipline yourself to develop the humility to accept cheerfully the constructive criticism of reviewers. Nothing could be less natural, but nothing else will succeed so well.

Things To Avoid

- Do not bore the reader. Trim the fat from your writing. Don't drag in extraneous information that bogs downs the text to impress the reader with your scholarship. A neat trick (that McCloskey does not mention but that works wonders in the war against wordiness) is to comb your writing for nouns that end in -tion, -ness, -ment, and -ility; locate the root verb and substitute it for the longer noun.

- Do not confuse the reader with "elegant variation," using fancy synonyms for straightforward terms. Substituting a term like "calamitous volume deficiencies" for "bad crops" is empty display and unnecessarily puzzles the reader, who may think the writer has introduced a new concept (p. 36).

- Do not use polysyllabic Latin and Greek words (those of more than one syllable, just to illustrate the point) when a simpler word is available. "Interim variation" is jargon; "change" is clearer (p. 49).

- Avoid overly long and convoluted sentences that trip up the reader who must often reread to understand (p. 38). Sentences that begin with lengthy prepositional phrases or dependent clauses often require additional punctuation, which will complicate your prose and retard the reader.

- Do not use third-person impersonal pronouns with the passive voice (such as "it was done") or the first-person plural pronoun ("we") to strike a remote, pseudo-scientific pose. Using "I" is acceptable social science usage and is preferable to combining passive constructions with dangling modifiers (a practice rampant in economic writing). It's far better to say "I found" than "using X method, it was found that. . . ." Do not use the "editorial we" when speaking only for yourself.

- Do not rely on adverbs and adjectives to dramatize your message (pp. 42-43). Excise the weak adverb "very," as in "a very illuminating concept." Write with concrete nouns and action verbs whenever you can (p. 18). McCloskey has compiled a list of "Bad Words" to avoid (pp. 44-47): vague nouns and pronouns (structure, process, time frame), feeble verbs (implement, hypothesize, occur), pointless adjectives (interesting, intra/inter, aforementioned), useless adverbs (fortunately, hopefully, respectively), and clumsy conjunctions (due to, in terms of, thus).

- Do not clog sentences with nominal compounds, or noun strings, like "Cobb-Douglas production function estimation approach" (p. 50). No one can decode such language without enormous effort. Re-examine any phrase with more than one adjective, determining how you might improve it either by deleting modifiers or by recasting it and supplying prepositional phrases (for example, "Cobb-Douglas' approach to specifying the production function").

- Do not use abbreviations without defining them first (p. 51), as in Economic Research Service (ERS). Keep the initials you do use to a minimum because your reader will resent being drowned in alphabet soup.

- Do not rely on the demonstrative pronouns and adjectives "this," "that," "these," and "those," to guide the reader through the logical progression of your argument (p. 52). "This" and its variations plague economic writers. "This" interrupts the flow of a paragraph, forcing the reader to search for its antecedent (the noun to which "this" refers). Repeat the noun. Remember, repetition clarifies the meaning for the reader.

The Bottom Line

McCloskey's book is worth every minute of the hour you may spend reading it. It's a pity the book is so difficult to find and that university bookstores don't yet stock it.

The test of the book is in its application. You won't have truly read it until you've measured your own writing against its precepts.

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